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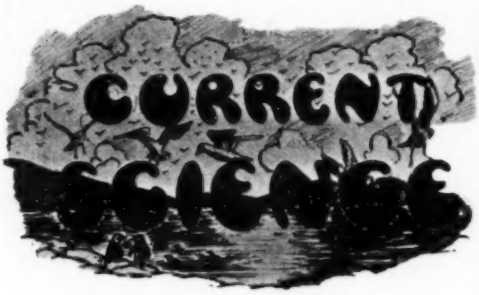

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Services and Salary-Cuts.*

THE Budget forecast for 1933-34 being expected to yield a surplus, is made the occasion by the various commercial and industrial organizations for pressing on the Central and Local Governments their claims for remission of emergency taxes imposed on trade and produce of the land. At the recent conference of Associated Chambers of Commerce in Calcutta, the following resolution was passed: "This Association draws the attention of the Government of India to the heavy burden of taxation now borne by commerce and industry in this country and records its opinion that any improvement in the financial situation should be reflected in the first place by the alleviation of this burden." Judging from speeches in support of this motion, we infer that both Sir E. C. Benthall and Mr. G. L. Winterbotham are definitely of opinion that restoration of salary-cuts should not be permitted to take precedence over relief to businessmen and industrialists. On the discussions of the Madras Finance Committee the press reports that while a remission of land taxes was urged, the members recognized "the need on the part of the Government to honour their pledge to their servants and sought to impress on the Government the possibility of retaining at least a part of the cut, having regard to the fact that the economic crisis could not be said to have passed away sufficiently to justify any restoration of the entire salary-cut." The recommendations of the General Retrenchment Advisory Committee appointed by the Government of India are not known, but from lobby talks reported in the press it appears that the restoration of salary-cuts and reduced remuneration to the members of All-India and Provincial services were discussed and the Finance Member is stated to have pointed out that "it would not be fair to let the committee shoulder the burden of responsibility for the settlement of this important issue and that it would be much better if the problem were left to the Government to solve on its own responsibility." In the meantime the Bombay Reorganization Committee have presented their report recommending new groupings of services and reduced differential rates of salaries.

*The Madras Retrenchment Committee Report has appeared since this was written. We propose to consider it in a subsequent issue.

We can only hope that the brighter financial position anticipated during the next official year will not be fugitive, because even a political Isaiah cannot prophesy the destiny of world trade, industry and finance. They are so closely linked with the wider and more vital issue of war-debts that unless these are abolished financial prosperity must remain a chimera. It is certainly premature for the Government to accept the recommendations of the Retrenchment Committees without a definite knowledge of the fresh financial burdens which the political reforms may impose on the country. The financial disruption of the year 1932-33 was the crisis of events which, dating from 1919, finally unhinged the whole economic system of the countries involved in the Great War. Is there any justification, however, for supposing that financial depression, economic dislocation and industrial disorganization will be the future normal complexion of political and economic life? We prefer to think that the spectre will be eventually banished by trade prosperity, though it is evident that first some satisfactory solution of the war-debts problem must be reached, of which there seems to be no immediate prospect.

The Bombay Retrenchment Committee opens its report with the pragmatical sentence, "There is probably no direction in which there is greater room for permanent retrenchment than that of the pay of the services." Inspiration for such a baleful dictum may be the statement reported to have been made by Sir George Schuster when introducing the budget in March last, namely, "A democratic Government is certainly going to cost more and unless you can reduce the standard of pay throughout the services, I do really foresee very great difficulties before this country." Does the apprehension of the Finance Member suggest that he foresaw permanent shrinkage in the revenues for a sufficiently long time to justify his remarks about a general reduction of salaries? Now the financial position in some provinces and in the Central Government has altered for the better. If this improvement is a temporary accident, the Associated Chambers of Commerce, the Landholders' Association and the Services cannot press for any alleviation, until the Government are in a position to gauge their financial position with reference to the reforms. In fact, it is difficult to see how in the present state of uncertainty about future commitments, commerce and industry alone can be favoured without a corresponding relief being given to the members of the public service. If, however, it can be proved that the general revenues will be augmented by reducing taxes on land, industry and commerce, and the Government were so to limit their relief, we are of opinion that the services will accept such a decision in a cheerful and patriotic spirit, hoping for a permanent and steady improvement of the situation in which their sacrifice and hardship will not be forgotten.

Reduction in the salaries of the different grades of appointments as a temporary measure may be comparatively harmless, but as a permanent feature of the services, it raises once again the old issue specified in the report of the Islington Commission, "The Government should pay so much and so much only to their employees as is necessary to obtain recruits of the right stamp and maintain them in such a degree of comfort and dignity as will shield them from temptation and keep them efficient for the term of their services." The Lee Commission has stated emphatically that the basic pay of the services should not be reduced.

It is true that the cost of administration must not exceed what the country can bear, but it is dangerous to reduce the pay of officers to scales which may not shield them from temptation. It would be an act of high statesmanship to achieve permanent reduction in the cost of administration without affecting the tone and spirit of its members built up so laboriously through generations, and without injuring the true interests of a vast multitude of uneducated and helpless people whose best protection is the service tradition of integrity and efficiency. The stability and success of democracy depend less on retrenchment of cost than on outlook and temper. It is doubtful whether reduced scales of pay in public administration will continue to attract the gifted members of the universities, while commerce, law and medicine offer more glittering prizes to industrious and talented young men.

If the returning prosperity finds the Government still compelled to reduce remuneration in the services, there are two ways of treating such a reduction. The cost of educating the children, house-rent and medical bills are important items in the domestic budget of every Government official and the difference between the old

and reduced rates,—if the latter prove inevitable,—might be made good to the services by providing reasonable relief in these directions. The financial sacrifice which an officer is called upon to make might be compensated by free education of his children, free medical service for the family and a house allowance calculated at five per cent on the salary, subject to a maximum of rupees one hundred. In this case a uniform salary-cut of ten per cent will not be equitable, but a graded scheme of five per cent on salaries upto five hundred, ten per cent upto a thousand and fifteen per cent on higher salaries will have to be considered especially in view of the fact that under a permanent cut, the existing standard of life becomes upset by seriously diminishing the margin of comforts and provision for the family.

This scheme may, however, prove no cheaper than the continuance of present rates of pay and we, therefore, suggest another alternative. In times of budget surplus the savings accruing from the reduction of salaries may be consolidated in Service Trust Funds which will be available for utilization by the Government. At the time of retirement the officer would receive a bonus of fifty per cent of the amount which has accumulated to his credit through the cut in the salary. He may not be permitted to obtain any loan from the Funds nor be entitled to claim interest. This bonus will be purely in the nature of provision for the family which occupies the anxious thoughts of all Government servants at all times. In case of death the family would receive the whole amount which has accrued to the credit of the officer though no interest need be paid. While a prosperity budget is certain to provide opportunities for every community and institution to benefit, it is not fair to single out one class of devoted servants for unconditional sacrifice. The second scheme that we have suggested imposes no additional burdens on commercial and agricultural classes, nor will they unhinge the budget of the Government. Will it not be found to allay the apprehension that "the democratic government in India is certainly going to cost more"? It will certainly preserve unimpaired the high reputation of the public services which their members have built up through generations of hard work and devotion to duty. It is almost a truism to say that the greatest and safest asset of the people under any form of government is an efficient, loyal and pure administration and the reformed government in India will be able to protect and advance the interests of her people only by maintaining the best traditions of her public service.

Verification of the Phenomenon of Partial Absorption of Soft X-Rays.

By Dr. M. N. Saha, D.Sc., F.R.S., *Allahabad.*

A RECENT communique by F. G. Chalklin and L. P. Chalklin to the Academy of Sciences, Paris (*Compt. Rend.*, 1932, **194**, 374)* deals with the verification by a new method of the phenomena of Partial Absorption of X-ray quanta by Dr. B. B. Ray of the University College of Science, Calcutta, which was first announced in *Nature*, **125**, 1930, and published in greater detail in the *Zs. f. Physik*, **66**, 231. Dr. B. B. Ray observed that when monochromatic X-rays (say Ni $K\alpha$, or $K\alpha$ and $K\beta$ of Fe) are passed through thin layers of light elements like Carbon, Oxygen and Nitrogen and spectro-photographed, there appear on the plate, besides the original line, lines at lower frequencies corresponding to $\nu - \nu'$ where ν is the frequency of the original irradiating quanta, and ν' is the characteristic K absorption of the element traversed. At first, Dr. Ray was inclined to the view that the modified line was an X-ray analogue of Raman Effect, but in a subsequent issue of *Nature*, **127**, 305, 1932, it was pointed out simultaneously by Dr. Ray and by Messrs. Bhargava and Mukherjee (Allahabad) that the phenomenon was due to absorption of part of the quantum by the electrons in the K shell of the medium traversed. What happens may be thus described:—As a quantum passes through the K shell of C (or any other light element), it gives to the K electron just sufficient energy so that it may be removed to infinity; so it is deprived of this amount from its stock of energy and reappears as a modified quantum with the energy content $h(\nu - \nu')$. Bhargava and Mukherjee further pointed out that this phenomenon might be treated along with the class of phenomena investigated by Robinson and De Broglie in which X-ray

* See Research Notes, p. 247.

quanta are allowed to traverse matter, and liberate electrons, and the energy of the liberated electrons is found to be $h(\nu-\nu')$. This is a case in which the whole energy of quantum is delivered to the electron, while in the case discussed here only a part just sufficient to liberate the electron is imparted. These are two extreme cases, and one is justified in assuming that the process is continuous, *i.e.*, a passing quantum can give to an electron inside an atom an amount of energy just equal to or greater than the amount required to liberate it, the excess appearing as the K. E. of the electron. The maximum K. E. should be $h(\nu-\nu')$ as observed by Robinson and others. But these authors did not examine the state of the quantum after it had traversed matter which was done by B. B. Ray. If the above view be correct the modified quanta should appear as a band with a sharp limit at $\nu-\nu'$ as observed by Ray, and extending to the long wave-length side indefinitely up to $\nu=0$. This band was actually observed by Bhargava and Mukherjee (*Nature, loc. cit.*). In spite of the fact that Ray's discovery is theoretically quite possible, and has been verified by other Indian workers, the reality of the effect was doubted, because many European and American workers were unable to reproduce it in the laboratory (*vide* para 2 of Chalklin's note). The following communication is important, because it is the first verification in a European laboratory, of not only the phenomena discovered by Ray, but also of the important feature of the case pointed out by Bhargava and Mukherjee. It is all the more important because in this experiment no crystal, which may give rise to false lines, but a grating was used. The failure of the other workers is to be attributed either to their use of large thicknesses of absorbing matter or to some other defect in their technique. It may also be pointed out that the phenomenon is extremely rare. Calculation with the data of one experiment has shown that only one quanta in 10^9 is modified by part-absorption on its passage through matter.

The Magnetic Moment of the Nucleus.

By Prof. B. Venkatesachar, M.A., F.Inst.P., *Central College, Bangalore.*

IN an attempt to explain the hyperfine structure exhibited by spectral lines Pauli introduced the hypothesis that the nucleus has a spin and consequently a magnetic moment. He also pointed out that investigations of the Zeeman effect of hyperfine structure would throw light on the magnetic properties of the nucleus. This hypothesis received full confirmation from the classical work of Back and Goudsmit on the hyperfine structure of Bismuth lines. The observed hyperfine structures conformed to the interval and intensity rules and the Zeeman effect was determined to be $4\frac{1}{2}\ h/2\pi$. Since this pioneer work the hyperfine structure of many elements has been investigated, and the spins of the corresponding nuclei have been deduced. In some cases the spin has also been calculated from the alternation of intensity in band spectra and the values found are small integral multiples of $\frac{1}{2}\ h/2\pi$. Now, the spin and the magnetic moment of the electron are related so that e/mc times the spin is equal to the magnetic moment. If a similar relation be supposed to hold in the case of the nucleus also, its magnetic moment should be expected to be of the order of 1/1835 of a Bohr magneton, since the mass of a proton is 1835 times that of the electron. It is found that the electrons in the nucleus must be supposed to have lost their spin in order to be able to understand the smallness of the g(I) factors of nuclei. A knowledge of the g(I) factor can be obtained in the following way:—

The fact that the interval rule is applicable to hyperfine structure separations is contained in the equation

$$W_{ij} = A\ (j)\ ij\cos\ (ij) \ldots\ldots\ldots\ldots (1)$$

Here A(j) is the interval factor; a theoretical expression for it has been obtained by Fermi, Breit and Cassimir, as also by Goudsmit, in the case of a single valence electron, not of s-type. The expression is

$$A(j) = \frac{l(l+1)}{j(j+1)} a_{nl} \ldots\ldots\ldots\ldots\ldots (2)$$

where a_{nl} is the interaction constant of the valence electron. Its value can be calculated rigorously only by a quantum-mechanical treatment of the state under consideration. But for non-s-types of penetrating orbits it is approximately given in cm.$^{-1}$ by

$$a_{nl} = \frac{R\alpha^2 Z_i Z_o^{\ 2}}{n_e^{\ 3} l(l+1)(l+\frac{1}{2})} g(I) \ldots\ldots\ldots (3)$$

Here Z_i and Z_o are the effective nuclear charges in the inner and outer parts of the orbit and n_e is the effective total quantum number. When there are more valence electrons than one the interval factor $A(j)$ can be expressed in terms of the interaction constants a_{nl} of the several electrons by making use of the method of energy sums as shown by Goudsmit (*Phys. Rev.*, **37**, 668, 1931). In this way one obtains for the 6s6d configuration the equations

$$\tfrac{1}{12}\, a_{6s} + 2\, a_{6d} = A(^3D_2) + A(^1D_2) \ldots (4)$$
$$-\tfrac{1}{4}\, a_{6s} + 2\, a_{6d} = A(^3D_1) \ldots\ldots (5)$$

while for the 6s6p state one gets

$$\tfrac{1}{4}\, a_{6s} + \tfrac{2}{3}\, a_{6p} = A(^3P_2) \ldots\ldots (6)$$
$$\tfrac{1}{4}\, a_{6s} + 2\, a_{6p} = A(^3P_1) + A(^1P_1) \ldots (7)$$

The 6s7s configuration yields the equation

$$\tfrac{1}{2}\,(a_{6s} + a_{7s}) = A(^3S_1) \ldots\ldots (8)$$

The propriety of applying these equations to any particular case can be tested by the consistency of the values of a_{6s} obtained from the various configurations. The g(I) factors of two nuclei can be compared by means of (3) when the values of a_{nl} are known in each case for the same value of n and l. Such a comparison is particularly instructive in the case of the two mercury isotopes Hg_{199} and Hg_{201} since here the two nuclei differ only by two protons and two electrons (*i.e.*, by two neutrons if the electrons are supposed not to have a separate existence).

The values of $A(^3D_2)$, etc., can be obtained from the analysis of Schüler and Jones (*Zs. f. Phys.*, **77**, 809, 1932). We have

$A(^3D_2) + A(^1D_2) = \frac{2}{5}(0{\cdot}752 - 0{\cdot}470) = 0{\cdot}113.$
$A(^3D_1) = -\frac{2}{3}(0{\cdot}493) = -0{\cdot}329.$
Hence from (4) & (5), $a_{6s} = 1{\cdot}326$ cm.$^{-1}$
$A(^3P_2) = (\frac{2}{5})(0{\cdot}758) = 0{\cdot}303;$
$A(^3P_1) + A(^1P_1) = \frac{2}{3}(0{\cdot}727 - 0{\cdot}181) = 0{\cdot}364.$
Hence from (6) and (7) $a_{6s} = 1{\cdot}150.$

The value of a_{6s} for Tl II, obtained from the same configurations are (see McLennan, McLay and Crawford, *Proc. Roy. Soc.*, **A 133**, pp. 657 and 663, 1931) 5·85 and 4·88 respectively. The ratio of the g(I) factors of Hg and Tl can now be calculated from (3). We thus obtain

$$\frac{g(\mathrm{I})_{Hg}}{g(\mathrm{I})_{Tl}} = \frac{(a_{6s})_{Hg}\,(n_e)^3_{Hg}\,(Z_i)_{Tl}\,(Z_o)^7_{Tl}}{(a_{6s})_{Tl}\,(n_e)^3_{Tl}\,(Z_i)_{Hg}\,(Z_o)^7_{Hg}}$$
$$= 0{\cdot}73 \text{ and } 0{\cdot}77 \text{ respectively.}$$

Thus the g(I) factors of Hg_{199} and Tl are of the same order. We can now calculate a_{6s} from (8) as follows: a_{7s} of Tl I = 0·417 cm.$^{-1}$ n_e for $7s^2S_{\frac{1}{2}}$ of Tl I is 2·19; n_e for $6s7s^3S_1$ of Hg I is 2·24, while for $6s7s^1S_0$ of Hg I it is 2·32; hence n_e for Hg I 7s is 2·28. Z_i is 80 for Hg and 81 for Tl. Therefore from (3) a_{7s} of Hg I is 0·274. But since $A(^3S_1)$ of Hg_{199} is $\frac{3}{4}$ (1·070) = 0·713, (8) yields a_{6s} = 1·152. This value lies between the values 1·326 and 1·150 previously obtained; similarly, the corresponding value in Tl II, *viz.*, 5·40 lies between those obtained from the 6s6d and 6s6p configurations, *viz.*, 5·85 and 4·88. The consistency of these results shows that we are justified in applying the theory in the above manner.

A similar calculation in the case of Hg_{201} gives a_{6s} the value −0·495 from the 6s6d configuration and −0·445 from the 6s6p configuration. Thus the g(I) factor of Hg_{201} is 0·38 times (mean of 0·387 and 0·373 obtained from the two pairs of values) that of Hg_{199}. The problem is to draw conclusions about the structure of the nuclei from the knowledge of the ratio of their g(I) factors.

Following the discovery of the neutron, Heisenberg (*Zs. f. Phys.* **77**, 1, 1932) has shown that observed facts can be best explained by giving up the idea of the separate existence of electrons inside the nucleus, considering it to be made up of protons and neutrons alone. Remembering the great stability of α- particles we may assume that pairs of protons and neutrons are as far as possible combined into α- particles. When the atomic number is even there will be only α- particles and neutrons, while if Z is odd, there will be one extra proton. Since Hg_{199} and Hg_{201} differ only by two neutrons, the latter must be thought of as having orbital motion as well as spin, in order to understand the difference in their g(I) factors. Making this assumption, it has been shown (B. Venkatesachar and T. S. Subbaraya, *Cur. Sci.*, **1**, 120, 1932) that the neutron configuration of Hg_{199} is $4d^25s$. The g factor of the corresponding $^2S_{\frac{1}{2}}$ term is 2. The neutron configuration of Hg_{201} is $4d^35s^2$ and corresponding to the spin 3/2, the term may be $^2D_{3/2}$, $^4P_{3/2}$, or $^4F_{3/2}$. The g factor of Hg_{201} is therefore 4/5 or 26/11 or 2/5. The ratio of the g(I) factors of Hg_{201} and Hg_{199} deduced above may be understood if the state of Hg_{201} is assumed to correspond to $^2D_{3/2}$. The calculated value of the ratio of the g factors will then be 0·40 in good agreement with the value 0·38 found above.

Comparing Hg_{199} and Tl the magnetic moment of Hg_{199} should be that of a neutron, while that of Tl is due to a proton. If now the neutron is thought of as a sphere of positive electricity imbedded in a sphere of negative electricity which is very much larger, the entire structure rotating with one angular velocity, and the moment of the whole being $\frac{1}{2}\,h/2\pi$, its magnetic moment will be of the same order as that of the proton, and the approximate equality of the g(I) factors of Hg_{199} and Tl become intelligible.

Next considering Tl and Pb, the term corresponding to the spin $\frac{1}{2}$ in the case of Pb may be $^4D_{\frac{1}{2}}$ or $^4P_{\frac{1}{2}}$ or $^2P_{\frac{1}{2}}$, so that the g factor may be 0 or 8/3 or 2/3. If the term is taken to be $^2P_{\frac{1}{2}}$, the ratio of the g factors of Tl and Pb comes out to be (magnetic moment of the proton) / (one-third of magnetic moment of the neutron), that is 4, if the magnetic moment of the neutron is assumed to be 0·75 times that of the proton on the basis of our previous comparison of Hg_{199} and Tl. The value deduced by McLennan is between 3·7 and 5 (*loc. cit.* p. 666), thus agreeing with the theoretical value.

To interpret the ratio between the g(I) factors of Tl and Bi deduced by McLennan (from 3·2 to 4·4; *loc. cit.*, p. 665) we have to consider the spin $4\frac{1}{2}$ of the Bi nucleus as due to a $^3G_5$ term with the spin of the proton oppositely directed. Then the magnetic moment of the Bi nucleus $= \frac{6}{5} \times 5 \times \frac{3}{4} - 1 = \frac{7}{2}$ so that its g factor $\frac{7}{2} \times \frac{2}{9} = \frac{7}{9}$. Hence the ratio of $g(\mathrm{I})_{\mathrm{Tl}}$ to $g(\mathrm{I})_{\mathrm{Bi}} = 18/7 = 2{\cdot}6$. In this case the numerical agreement is not so good as before, but considering the uncertainties in the value deduced by McLennan, as also in the ratio between the magnetic moments of the proton and the neutron, exact numerical coincidence cannot be expected. Considerations of a similar nature may be expected to lead to an understanding of the extremely small value of the g(I) factor in the case of elements like chlorine.

A Note on the Special Theory of Relativity.

By Prof. A. C. Banerji, M.A., M.Sc., I.E.S., *Allahabad University.*

IT has been pointed out (*Current Science*, 1, 160, 1932) that if there are two particles A and B of rest masses m_1 and m_2 (with respect to each other) moving with a relative velocity v, the total mass of the system can be calculated in two different ways. If m_1 be assumed to be at rest then the total mass of the system is found to be $m_1 + \frac{m_2}{\sqrt{1-\frac{v^2}{c^2}}}$ where c is the velocity of light. On the other hand, if m_2 is supposed to be at rest the total mass of the system becomes $m_2 + \frac{m_1}{\sqrt{1-\frac{v^2}{c^2}}}$. Clearly, these two expressions for the total mass are different.

In the first case the total energy of the system apart from the interaction energy (which, if any, will be the same in both the cases) is

$$m_1c^2 + \frac{m_2c^2}{\sqrt{1-\frac{v^2}{c^2}}}; \quad i.e., \; m_1c^2 + m_2c^2 + \tfrac{1}{2}\, m_2v^2$$

neglecting terms of higher order of small quantities. In the second case the total energy apart from the interaction energy would become $m_2c^2 + \frac{m_1c^2}{\sqrt{1-\frac{v^2}{c^2}}}$;

$$i.e., \; m_2c^2 + m_1c^2 + \tfrac{1}{2}\, m_1v^2$$

neglecting terms of higher order of small quantities. These two expressions for energy are different.

We also see that according to the observer A the total linear momentum of the system is $\frac{m_2v}{\sqrt{1-\frac{v^2}{c^2}}}$ and according to the observer B it is $\frac{-m_1v}{\sqrt{1-\frac{v^2}{c^2}}}$. These two expressions are evidently numerically different.

If there are two or more observers we can show more generally that the total energy of a system of particles becomes different when measured by different observers; and the law of conservation is not true in this sense, and the total energy is not an absolute property of the system. However, it is quite possible that for each particular observer the total energy may remain constant throughout the motion, but it is no new principle. The above remarks apply

equally well to the case of total linear momentum.

We shall see presently that the principle of relativity creates another difficulty to which attention has not been drawn before, *viz.*, failure of the concept of the centre of mass as a definite point. It is necessary to call attention to this fact, as when dealing with a number of particles, the concept of the centre of mass has sometimes been used.

Let us take, as before, two particles A and B having the rest masses m_1 and m_2 and let them start moving with respect to each other with the velocity v.

Let B′ be the point which is at rest with respect to A but which momentarily coincides with B at the instant t measured by A. Let AB be equal to r as measured by A. Now, for the observer at A the problem is reduced to a statical case of finding out the centre of mass of two masses m_1 and $\frac{m_2}{\sqrt{1-\frac{v^2}{c^2}}}$ at A and B′ respectively. Let the centre of mass be G_1 as found by A. Then according to the measurement of A

$$AG_1 = \frac{m_2 r}{\sqrt{1-\frac{v^2}{c^2}}} \Big/ \left[m_1 + \frac{m_2}{\sqrt{1-\frac{v^2}{c^2}}}\right]$$

$$= \frac{m_2 r}{m_1+m_2} + \tfrac{1}{2}\,\frac{m_1 m_2\, v^2 r}{(m_1+m_2)c^2}$$ (neglecting small quantities of higher orders).

$$B'G_1 = -\left\{\frac{m_1 r}{m_1+m_2} - \frac{\frac{1}{2}\,m_1 m_2\, v^2 r}{(m_1+m_2)c^2}\right\}$$ (neglecting small quantities of higher orders).

Similarly, take A′ to be the point which is at rest with respect to B but which momentarily coincides with A at the instant t' measured by B. In order that BA′ may be numerically equal to AB′ we have to take t and t' suitably related.

We have $AB' = a + vt$, *i.e.* when $t = 0$ as measured by A the distance between the particles was 'a' according to A. Further, $BA' = -(b + vt')$, *i.e.* when $t' = 0$ as measured by B the distance between the particles was $(-b)$ according to B so that in order that $(AB') = -(BA')$ (as measured by A and B respectively) we get $a + vt = b + vt'$ *i.e.*, $t' - t = \frac{a-b}{v}$. We see that a and b depend upon the initial conditions of the problem.

Now for the observer at B the problem is reduced to a statical case of finding the centre of mass of masses $\frac{m_1}{\sqrt{1-\frac{v^2}{c^2}}}$ and m_2 at A′ and B respectively. Let the centre of mass be G_2 as found by B. Then according to the measurements of B

$$BG_2 = \frac{-m_1 r}{\sqrt{1-\frac{v^2}{c^2}}} \Big/ \left[m_2 + \frac{m_1}{\sqrt{1-\frac{v^2}{c^2}}}\right]$$

$$= -\left\{\frac{m_1 r}{m_1+m_2} + \tfrac{1}{2}\,\frac{m_1 m_2\, v^2 r}{(m_1+m_2)c^2}\right\}$$

(neglecting small quantities of higher order);

also $A'G_2 = \frac{m_2 r}{m_1+m_2} - \frac{1}{2}\,\frac{m_1 m_2\, v^2 r}{(m_1+m_2)c^2}$ (neglecting small quantities of higher order).

Expressions for AG_1 and $A'G_2$ are different.

We know that if two systems of reference A and B move with a relative velocity v then to an observer on A the unit of length of A along the line of relative motion appears to be in the ratio $\sqrt{1-\frac{v^2}{c^2}} : 1$ to that of B while to an observer on B the unit of length of B along the line of relative motion appears to be in the ratio $\sqrt{1-\frac{v^2}{c^2}} : 1$ to that of A. To the observer A the distance $A'G_2$ will appear to be

$$\frac{m_2 r}{m_1+m_2} \cdot \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{1}{2}\,\frac{m_1 m_2\, v^2}{(m_1+m_2)\,c^2} \cdot \frac{r^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

i.e., $\frac{m_2 r}{m_1+m_2}$ (neglecting small quantities of higher order).

Even for observer A, G_1 and G_2 are different points. The concept that the centre of mass is a definite point with respect to any configuration of particles fails.

Now m_1 and m_2 are the masses of two particles A and B when they are relatively at rest with respect to each other. Eddington calls them "proper masses" or "invariant masses" and assumes that they have absolute inertial properties and remain unaltered throughout the vicissitudes of their history (Eddington's *Mathematical Theory of Relativity*, p. 30). Let us examine Eddington's assumption a little more carefully. There are two possibilities:—

(*a*) The rest masses m_1 and m_2 of any two particles A and B with respect to each other have the same values in presence of other bodies whatever be their common relative velocity with respect to each of these bodies.

(*b*) The values of the rest masses of A and B with respect to each other may change in the presence of other bodies by amounts which depend on the magnitude of their common relative velocity with respect to each of the other bodies.

Let us now examine the first possibility. Let there be three particles A, B and C. According to the hypothesis the rest masses of A and B between themselves remain the same irrespective of the presence of the third body C. Similarly, the rest masses of the particles A and C between themselves remain the same in spite of the third body B. Now let three bodies A, B and C be relatively at rest with one another and their rest masses with respect to one another be m_1, m_2 and m_3. According to the hypothesis, the rest masses m_1 and m_2 between A and B have not altered due to C and also the rest masses m_1 and m_3 between A and C are not altered due to B. If there is any other particle D we find that the rest masses between A and D are m_1 and m_4 irrespective of the presence of other bodies. So it follows that m_1 is an absolute property of the particle A if the first possibility is true. Let us see if this is borne out by facts.

Let M_1, M_2, M_3, etc. be the masses of the particles A, B, C, etc. and v_1, v_2, v_3, etc. be their relative velocities as measured by an observer S and let M'_1, M'_2, M'_3, etc. be the masses of the same particles and v'_1, v'_2, v'_3, etc. be their velocities as measured by another observer S'. Let u be the velocity of S with respect to S'. Then

$$M_1\sqrt{1-\frac{v_1^2}{c^2}} = M'_1\sqrt{1-\frac{v'^2_1}{c^2}},$$

as each of them is equal to m_1 in virtue of the first possibility. We have similar relations for other particles. Therefore we have

$$\Sigma M_1 v_1 = \Sigma M'_1 v_1 \frac{\sqrt{1-\frac{v'^2_1}{c^2}}}{\sqrt{1-\frac{v_1^2}{c^2}}}.$$

Now $$\frac{v_1}{\sqrt{1-\frac{v_1^2}{c^2}}} = \frac{1}{\sqrt{1-\frac{u^2}{c^2}}}\cdot\frac{(v'_1-u)}{\sqrt{1-\frac{v'^2_1}{c^2}}}$$

(see p. 31, *Mathematical Theory of Relativ ty*, Eddington).

So we get

$$\Sigma M_1 v_1 = \frac{\Sigma M'_1 v'_1}{\sqrt{1-\frac{u^2}{c^2}}} - \frac{u\Sigma M'_1}{\sqrt{1-\frac{u^2}{c^2}}} \quad ...(A)$$

Similarly we also get

$$\Sigma M'_1 v'_1 = \frac{1}{\sqrt{1-\frac{u^2}{c^2}}}\Sigma M_1 v_1 + \frac{u}{\sqrt{1-\frac{u^2}{c^2}}}\Sigma M_1 \quad ...(B)$$

Eddington has assumed, it appears rather arbitrarily, that the equation (A) is satisfied and has then come to the conclusion that the rest masses m_1, m_2, etc. are absolute properties of the particles. There does not seem to be any justification for such an assumption.

Clearly $\Sigma M'_1 v'_1$ is not equal to $\Sigma M_1 v_1$. When there are two or more observers total linear momentum of a system of particles becomes different for different observers, and the law of conservation is not true in this sense, and the total linear momentum is not an absolute property of a system of particles or bodies.

From (A) and (B) it is evident that if for each particular observer the total mass is conserved, then for him total linear momentum will also be conserved.

There is one serious difficulty, when we talk of any conservation theorem in connection with a number of particles in the theory of Relativity, as we have to bring in forces existing between them. This involves the idea of the distance, and the quantity giving the total energy or linear momentum becomes ambiguous. Hence it appears that we cannot talk of any conservation theory existing between a number of particles in the theory of Relativity.

Under the second possibility the rest masses are clearly not the absolute properties of the particles. Moreover, if m_1 is the rest mass of A with respect to B, then m_1 would not generally be the rest mass of A with respect to another particle C. It would be some other quantity m'_1. Each observer has his own particular world and measures the masses of the particles, their total energy and linear momentum in his own particular way. Unless some absolute property of each particle independent of the observer is conserved, there cannot be any correlation between the above quantities measured by different observers. Without any such correlation between measurements made by different observers the theory of Relativity cannot make much progress in explaining natural phenomena. So we see that some such postulate as the rest mass of a particle remains invariant throughout the vicissitudes of its history has become necessary.

Letters to the Editor.

A Search for the Hall Effect in Colloidal Electrolytes.

THE rotation by the magnetic field of the equipotential lines in a metallic plate carrying an electric current has been established by Hall[1] and a number of subsequent investigators[2]. Theoretically the existence of the above effect in electrolytes and in liquid metals is a possibility, but, perhaps, on account of the practical difficulties its complete establishment is a difficult proposition. Attempts made by Roiti,[3] Floria,[4] Chiavassa[5] and others have yielded negative results. The only positive results have been obtained by Oxley[6] and Baggard[7]. Since the discovery of the colloidal electrolytes by McBain[8] and his co-workers a considerable amount of work has been done to establish the electrolytic conductivity of the colloidal solutions. On account of the size of one of the conducting micelles the case of these substances presents special attraction from the point of view of the Hall effect.

A preliminary but a very searching examination has been made of solutions of sodium stearate with alcohol and water as solvents. The original method of Hall of connecting two transverse equipotential points to a galvanometer was tried. A rectangular cell of glass ($8\times3\times0\cdot15$ cm.) was prepared and placed in a magnetic field varying from 6,000 to 13,000 gauss. The electrodes were of silver and the distance between the primary electrodes was about 1 cm. The primary current was 3 microamperes as a greater current makes the galvanometer unsteady on account of gas bubbles produced. The upper Hall electrode was capable of very fine motion both in horizontal and vertical directions. It was adjusted to the same potential as the lower one and brought very near it so that the resistance between these may be small. In our experiments this was of the order of 600 ohms. The accuracy and sensitivity of the arrangement was tested by trying thin silver films which gave Hall effect of the right order. There was a large throw of the galvanometric needle due to induction but no permanent deflection, showing that under these conditions there is no Hall effect in sodium stearate solution. It is interesting to note that when one Hall electrode was in advance of the other a longitudinal galvanometric effect, reversible with the primary current but not with the magnetic field was observed. Experiments are in progress to investigate this effect and Hall effect in colloidal gels.

Our thanks are due to Prof. S. S. Bhatnagar for suggesting this problem.

S. S. KOHLI.
R. S. JAIN.
University Chemical Laboratories,
Lahore.
January 10, 1933.

[1] Hall, E. H., "On the New Action of Magnetism on a Permanent Electric Current," *Phil. Mag.*, **5**, 10, 301, 1880.

[2] Von Ettingshausen, A., and Nernst, W., "Ueber das Hallsche Phanomen." *Zeit. Phys. Chem.*, **2**, 104, 1888.

[3] Roiti, A., "Ricerca del Fenomeno di Hall nei Liquidi," *Jour. d. Phys.*, **2**, 2, 513, 1883.

[4] Floria, F., II. "Fenomeno di Hall nei Liquidi," *Nuov. Cim.*, **4**, 4, 106, 1896.

[5] Chiavassa, F., "Sul Fenomeno di Hall nei Liquidi," *Nuov. Cim.* **4**, 6, 296, 1897.

[6] Oxley, A. E., "The Hall Effect in Liquid Electrolytes." *Proc. Roy. Soc. Lond.*, **A. 88**, 588, 1913.

[7] Baggard, H., "Sur le Phenomene de Hall daus les Liquides." *Compt. Rend.*, **122**, 77, 1896.

[8] McBain and Taylor, *Zeit. f. Physic. Chem.*, **76**, 179, 1911; McBain, Laing and Titley, *Trans. Chem. Soc.*, 1279, 1919.

N.B.—The complete bibliography upto 1923 after which no work has been done on Hall effect in electrolytes is given on page 101 of Campbell's "Galvanometric and Thermo-Magnetic Effects".

The Viscosity of Aqueous Solutions of Non-Electrolytes.

As we do not know the forces operating between the molecules of non-electrolytes in solution, it is almost impossible to derive the viscosity of non-electrolytic solutions on kinetic grounds. However, by the application of Porter's empirical rule[1] to the law governing the vapour pressure of solutions it is possible to derive an equation connecting viscosity and concentration.

Porter states (*loc. cit.*) that $1/\log\eta$ plotted against $\log p$ (where η represents the viscosity and p the vapour pressure of a liquid at the same temperature and pressure) gives a straight line. In other words $\log\eta = m\log p + k$ ..... (1).

Assuming that Porter's rule holds for dilute solutions too—an assumption which seems to be justified by facts—we can connect viscosity with concentration by continuing equation (1) with $\frac{p_0-p}{p_0}=\frac{n}{N}$ (2) where

[1] *Phil. Mag.*, April 1932, p. 460.

p_0 represents the vapour pressure of the pure solvent, p that of the solution, η represents the number of moles of the solute and N that of the solvent present in the solution.

The equation obtained is:—

$$\eta/\eta_0 = \left(1 - \frac{n}{N}\right)^m$$

where η represents the viscosity of the solution and η_0 that of the pure solvent.

For dilute solutions the above equation assumes the form, $\eta/\eta_0 = 1 - m\frac{n}{N}$ which can be written as $\eta/\eta_0 = 1 + AC$ where "A" represents a constant and "C" concentration of the solute.

There is very little data to test the correctness or otherwise of this formula, but the existing data (the viscosity of sugar solutions given in Bornstein Landolt's table) seem to support the above theoretical deduction.

Experiments are being conducted in this Laboratory to test the formula obtained.

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Cuttack,
December 22, 1932.

Separation and Purification of Enzymes through Substrate Adsorption.

SPECIFIC adsorptions of enzymes by their respective substrates which are well known, have been utilized for the separation and purification of enzyme preparations. Ambard[1] has shown that crude powdered starch adsorbs amylase from solutions to the extent of 95 to 100 per cent. This method has been employed by him for the estimation of amylase in saliva, blood and urine. Waldschmidt Leitz and Linderstrom-Lang[2] have found that trypsin-kinase can be specifically adsorbed on casein made to precipitate in the enzyme solution itself.

This principle has been adopted in the separation and purification of inulase from its associated invertase. Inulase extract (P_H 3.0) was treated with a suspension of purified inulin at 0°C. for 15 minutes and centrifuged. The precipitate of inulin, on analysis, was found to have adsorbed inulase to the extent of 50 per cent from the enzyme extract, while it was entirely free from invertase. Such a complete separation is not possible with calcium hydrogen phosphate which has been recommended for the purpose. An effective separation can also be achieved by allowing a 3 per cent solution of inulin to precipitate in the enzyme extract by freezing and separating the adsorption complex by centrifuging. Under similar conditions of experiment a suspension or solution of starch adsorbs neither inulase nor the associated invertase.

The method has also been successfully employed for the separation of the liquefying and saccharifying components of malt diastase. Malt extract cooled to 0°C. was stirred with finely powdered amylopectin (prepared by the method of Ling and Nanji, *J.C.S.*, **123**, 2666, 1923) and centrifuged. It was found that while the saccharifying power of the centrifugate was unimpaired, its liquefying power as determined by viscosity measurements, alcohol precipitation or iodine coloration, was markedly decreased, indicating a partial (25 per cent) removal of the liquefying component.

A detailed study of the formation of the above adsorption complexes in relation to reaction and concentration of the enzyme and substrate is being made. This method should prove useful in separating other enzyme mixtures.

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The Colouring Matter of Khapli Wheat.

TRICIN, the colouring matter of "Khapli" wheat, was isolated by Anderson and Perkin[1], who showed that it was a dimethyl ether of a pentahydroxyflavone, tricetin (I), alkaline fusion of which led to phloroglucinol and an acid resembling gallic acid. They reported that (I), however, did not have the obvious structure of a 5: 7: 3′: 4′: 5′-pentahydroxyflavone (II), as a synthesis of the latter disclosed differences in the properties of (I) and (II).

(II) was first synthesised by Bargellini and Monti[2] and was described as decomposing

[1] *Bull. Soc. Chemie Biol.*, **3**, 51, 1921.
[2] *H. Zts. Physiol. Chemie*, **166**, 227, 1927.

[1] Anderson and Perkin, *J. Chem. Soc.*, **139**, 2624, 1931.
[2] Bargellini and Monti, *Gazzetta*, **45**, 65, 1915; *Chemical Abstracts*, **9**, 2237, 1915.

above 270° and yielding an acetyl derivative, m.p. 216-218°. Badhwar, Kang and Venkataraman[1] prepared (II) by the Robinson reaction; they found that their product was similar to Bargellini and Monti's in its colour reactions, but they did not prepare the pentacetate.

Anderson[2] has repeated the synthesis of Badhwar *et al* and has demonstrated the identity of (I) and (II). In view of the discrepancy between the m.p.'s of the acetyl derivatives of Bargellini and Monti (216-218°) and Anderson (241-242°), we have undertaken a re-examination of (II) and its derivatives.

If tricetin has the structure (II) we have little doubt that tricin is its 3′ : 5′–dimethyl ether (III). The wide occurrence of the syringic nucleus among the anthocyanins and the probability of its recognition among natural flavone pigments has been indicated by Karrer and Widmer[3] and by Heap and Robinson[4]. A synthesis of (III) by the interaction of phloracetophenone with *o*-benzylsyringic anhydride is in progress in this laboratory.

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January 30, 1933.

Feeble Anisotropies in Paramagnetic Crystals.

IT is known from the investigations of Rabi[5] and others that at ordinary temperatures single crystals of manganous salts are almost isotropic magnetically; the three principal susceptibilities differ from one another by less than one per cent. This result is what one would expect on the basis of the recent theories of Van Vleck and others[6] since the Mn^{++} ion is in an S state; and from the point of view of these theories a knowledge of the precise amount of deviation from perfect isotropy in these crystals is of some importance. For the purpose of measuring such feeble anisotropies as are involved here, we have adopted the following method:—

The crystal is suspended at the end of a calibrated quartz fibre so as to lie between the parallel pole-pieces of an electromagnet capable of giving a uniform field. When the field is put on, there will, in general, be two couples tending to rotate the crystal about the axis of suspension: (1) the couple due to the magnetic anisotropy of the crystal in the horizontal plane, and (2) the couple due to small deviations from homogeneity of the field, acting through the asymmetry of shape of the crystal. The latter couple is eliminated by surrounding the crystal with a paramagnetic solution (saturated with the substance) whose volume susceptibility has been adjusted to equal the mean volume susceptibility of the crystal.

The following two measurements suffice to determine the directions of the magnetic axes in the horizontal plane, as well as the difference between the susceptibilities along these axes. The crystal will rotate from the initial position when the field is put on; the first measurement is that of the angle of torsion of the fibre that is necessary to rotate the crystal back to its original orientation. If now the torsion head is rotated farther very slowly, at a certain stage the crystal suddenly turns round. This critical orientation of the crystal evidently corresponds to the maximum value of the restoring couple in the field, and therefore to an inclination of the two magnetic axes in the horizontal plane at 45° to the direction of the field. The angle of torsion for this orientation of the crystal is the second quantity measured.

By making similar measurements for other suitable axes of suspension of the crystal, the directions of the principal magnetic axes in the crystal and its anisotropy become known.

By way of illustration we may mention the results obtained by this method in the case of the monoclinic crystal $MnSO_4.(NH_4)_2SO_4.6\,H_2O$. We find that at 30° C.

$$\chi_1 - \chi_2 = 11{\cdot}4$$
$$\chi_1 - \chi_3 = 6{\cdot}8$$
$$\tfrac{1}{3}(\chi_1 + \chi_2 + \chi_3) = 13830$$

where χ_1 and χ_2 denote the two principal gram molecular susceptibilities in the (010) plane, expressed in the usual unit, *viz.*, 10^{-6} c.g.s. e.m.u. χ_3 denotes the susceptibility along the '*b*' axis. Also the χ_1 axis is found

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[1] Badhwar, Kang and Venkataraman, *J. Chem. Soc.*, **141**, 1107, 1932.
[2] Anderson, *Canad. J. Res.*, **7**, 285, 1932.
[3] Karrer and Widmer, *Helv. Chem. Acta*, **10**, 5, 1927.
[4] Heap and Robinson, *J. Chem. Soc.*, **135**, 68, 1929.
[5] I. I. Rabi, *Phys. Rev.*, **29**, 174, 1927.
[6] See J. H. Van Vleck, *The Theory of Electric and Magnetic Susceptibilities*, Chap. XI (1932).

to lie in the acute angle β at 14·6° to the 'c' axis. It is seen that the largest difference between the χ's is less than one-tenth of one per cent.

The significance of this small anisotropy will be discussed in detail elsewhere. It may, however, be stated here that when allowance is made for the anisotropy of the diamagnetic part of the susceptibility, the residual anisotropy is of the same order of magnitude as may be expected from the simple magnetostatic influences of the doublets induced in the Mn^{++} ions.

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The Industrial Outlook.

Development in Plastics.[1]

DURING the year 1932 the Plastics Group of the Society of Chemical Industry was formed of which group Mr. H. V. Potter, B.Sc., F.I.C., is the first chairman. The formation of this group within the Society had the possible effect of preventing the chemists and chemically minded technicians in the industry from grouping together to form a separate association of their own since neither of the existing bodies, the Trade Association or the Plastic Institute could be expected to cater for the purely chemical interests of this new industry.

Patent literature has continued during the year without abatement covering a few new types of plastics, modifications of existing types and application in particular fields for existing plastics. The older types such as celluloid, casein and natural resins have ceased to attract in the same way as the newer types such as the phenol-formaldehyde, urea-formaldehyde and more recently the cellulose ester and ether types. The nitrocellulose plastics, such as celluloid, have possibly ceased to hold the lead in tonnage production owing to the growth of the newer types. This class of plastics has steadily progressed and is still finding new applications along well-defined lines where inflammability is not a serious drawback. The finish, appearance and colour effects are still being improved and extended. Its use in safety glass has been hampered by the tendency to darken in colour.

The natural resin plastics, of which shellac is the largest ingredient, have unquestionably had a serious setback on account of the quiet state of the gramophone record industry. In spite of this, however, it is probable that it is the second largest class of plastics in the country. A large amount of work has been done on flexible records with the object of getting away from the use of shellac on account of the unstable price position of this material, and producing a record lighter in weight. So far the shellac record has not yet come up against a real rival in this respect on account of a number of technical and reproduction difficulties.

The natural resins, such as shellac, copal, kauri and collophony along with tung oil and other ingredients, namely, bitumen, continue to be used for the production of small moulded insulations where finish is not important or price rules out other types. The very cheapest type of pressed or moulded insulation is usually compounded of these products. The newer types of plastic moulding powders have ousted this class in many fields, but where high heat resistance is required on that occasion for outside insulation, such as strain insulation, telegraph and telephone pole insulation, they still have an extensive application chiefly on account of price.

The casein plastics continue to find extended applications chiefly for decorative purposes, and the combination of casein with other plastics such as phenol-formaldehyde resins has been successfully tried and such a product has found practical although limited application.

The synthetic resin plastics can still claim the honour of topping the list in number of patents taken out during the year, although the applications have shifted from the older, that is, the phenolic type, to the newer, that is, the urea, thiourea, glyptol and styrol types. The phenol-aldehyde resin plastics still represent the largest output of this group in tonnage production while the synthetic resin group can claim second place in total tonnage production during 1932. The more recent developments of this class of material have been the field of air drying varnishes as protection coatings. While

[1] *Development in Plastics*, by H. V. Potter, B.Sc., F.I.C., *Chemical Age*, **27**, 705, 1932.

they have certain drawbacks in respect to light resistance, their resistance to moisture and sea air is a great advance on any other type of resin finish. Judging by the patent literature, investigations are following the lines of maintaining their valuable resistance to weather but overcoming the darkening to light. The application of this class of synthetic resin into the abrasive wheel industry has enabled peripheral speeds of grinding wheels to be attained which have not been possible before. High speed snagging and cutting by abrasive wheels is only in its infancy in England, but in the United States very large developments have taken place in recent years along these lines and England is only waiting for the industrial revival to install the special machines which are necessary for running at high speeds.

The largest application for the phenol resinoids and the urea resinoids consists in the field of moulding. This development still continues unabated into new fields of application and it is difficult to find an industry into which synthetic resinoid mouldings have not obtained a footing. Some of these are the toy industry, constructional and building, decorative industries, electrical and engineering and packing trades, to mention only a few. Glyptal resins made from glycerol and phthalic acid have been slow in their development until the last year or two but are now finding extensive application in the paint and enamel industry. For this application the resin or its ingredients are usually reacted with tung oil to give a relatively pale resin which is oil soluble and has the advantage of permanence to light while showing good resistance to weather. They have proved to be a useful addition to the resinous ingredients available for paint and enamel manufacture and enable the ever-increasing demand for faster drying finishes to be met. Apart from this application, and these resins are useful as a bonding material for micanite sheet and tube insulation, they have not shown any marked development in other directions so far. This may be on account of the slowness with which they are converted to an insoluble and infusible stage. There does not appear to be any relatively sudden chemical change from the fusible to the infusible state comparable with the phenol or aminoresinoids, the change being gradual over a prolonged period and most likely involving a continuation of the metal reaction, and not a second chemical reaction such as takes place with the phenol type.

The urea and thiourea formaldehyde resins referred to as "aminoresinoids" have continued to attract investigators, technicians and industry during the year. They have their field of usefulness which, at present, lies particularly around their decorative value. They are not darkened by light and are practically water-white in contrast to the phenol resinoids. They have drawbacks in other directions, however, and their higher affinity for moisture renders them less suitable for insulation. Some work has been done on combining these resins with other types, such as the phenol resins, to render them more water- and moisture-proof, but without serious success so far. Development in the field of laminated decorative sheet has been carried on and one British company, much to its credit, supplied some of the wall decorations for the studios at Broadcasting House in sheet form in a very delicate colour which is not possible so far in any other type of synthetic resinoid. If the amino plastics could be rendered more weather-resistant or the phenol resinoids more light-resistant then the future possibilities of these materials would be increased many times.

The last, but not by any means the least, important group of plastics are the cellulose ethers and esters which may be spoken of as "cellulose plastics". Reference has already been made to celluloid which falls into a class of its own; the others are cellulose acetate and benzyl cellulose plastics. Both these products, by incorporation of suitable plasticisers soften under heat and pressure and are of the thermo-plastic but not thermo setting type, such as phenol, amino of glyptal plastics. They, therefore, must essentially be handled by the ordinary method for such plastics, that is pressing hot and cooling before ejection or by a special method which has been derived recently called "injection" moulding. In this process the cellulose plastic is placed on a closed steam jacketed cylinder, with a plunger at one end and a fine nozzle at the other to which the mould containing the desired shape of the finished article is attached. The material while hot and plastic is forced into the mould under pressure, the latter being kept cool. The nozzle is then closed and the mould opened and the moulding ejected in its finished state. This method of production of mouldings is very quick, and the equipment

relatively inexpensive, but until the cellulose plastics can be manufactured cheaper the application is limited to special uses where other plastics cannot be used. There is, however, a great possibility for this type of moulding and new developments may be looked for.

The manufacture of plastics is essentially a chemical industry and has thus followed in most cases routine chemical methods of manufacture. The utilization of plastics in various other industries is more allied to engineering than chemistry. On this side more ingenuity and development along specialized lines have been shown. While the hydraulic press has been available for many years the type and construction and general layout has been radically changed to meet the needs of the plastic moulding industry. There is, however, room for more development on the lines of continuous operations to cut out the large amount of handling that is still required. There has been very little real novelty in design of finished plastic products. The industry has grown so rapidly that plastics in most instances have only substituted some other material. The past rate of development cannot be expected to continue on these lines.

Plastics can now be obtained in so many forms and colour. Celluloid in sheet and moulded casein likewise is procurable in very beautiful colours. Synthetic resinoids are available in every conceivable type of moulding of dark, warm hues to pale colours, transparent or opaque, in sheet form or panelling, constructional, electrical and mechanical uses, while the cellulose plastics show promise of development into channels where the others cannot reach, such as for pens, pencils, small articles in colour effects quite characteristic of their own.

Virus Diseases of Plants.

AT a Joint Session of the Sections of Agriculture, Chemistry and Botany of the Indian Science Congress, a symposium on "Virus Diseases of Plants" was held during the Science Congress Week at Patna. Dr. S. L. Ghose presided over the meeting.

The subject was discussed under the following heads:—

Symptoms.

Morphological. [*M. Sreenivasaya.*]

The reaction of the plant to virus invasion manifests itself in diverse morphological transformations. The plant organ that is most easily susceptible and suffers the most distinctive and perceptible change, is the leaf; next comes the other aerial parts of the plant while the root is, generally, not visibly affected in the earlier stages of the disease, although this is affected in advanced stages. Symptoms at the root, however distinct and infallible, do not afford us a ready and easy method of diagnosis. It is fortunate, therefore, that the leaves of the plant are the first to suffer and exhibit the symptoms in a very decisive manner. We are thus in a position to recognize the malady at comparatively an early stage.

The symptoms generally appear with the vegetative growth and development of the affected plants; they rarely occur in tissues that are mature before infection. "Spike" of sandal appears with the bursting of dormant buds or at the growing points, as the case may be, and the general manifestation of the disease in forests synchronises with a season when the sandal plant passes through its vegetative phase of development.

Virus diseases are usually systemic in character but in the case of the higher woody plants, like sandal, the infective principle is confined to certain tissues and portions of the plant in the earlier stages of the disease. One-sided involvements with one-sided response to the effects of virus invasion, is not uncommon. Sandal spike and peach yellows afford striking examples of this phenomenon.

Mottling, chlorosis, necrosis, proliferation, dwarfing, curling, crinkling or corrugating, bunching, phyllody and sterility are some of the main symptoms which characterise virus-affected plants. The symptoms vary with the variety of the host affected. The leaf roll of potato, for example, which affects a large variety of potato plants, is accompanied in the case of the "President" variety by a pinkish discolouration of the leaflets. Most of the virus diseases stimulate starch production in affected tissues and this deposition lends the tissues a characteristic stiffness and brittleness.

Mottling is characteristic of the several mosaics, curling and crinkling, of the several leaf rolls and streaks, while dwarfing or stunting appears to be a general effect of all the virus infections. In some instances the "dwarfing" is so intense and general that the new flushes of growth result in "bunching" which is to be found, not only in sandal "spike" but also in the so-called "spikes" of *Vinca rosea*, *Z. oenoplia*, *Dudonea viscosa* and a number of other plants.

The "reproductive activity" of the plant is more or less affected in the case of virus-infected plants. The fruits become very small as in the case of cucumber mosaic, while in yet other instances the infection causes a complete sterility as in the case of sandal spike. In some cases the flower retrogrades to the leaf stage resulting in "phyllody"; this phenomenon is to be found in sandal and *Vinca rosea* spike.

The root systems of diseased plants are stunted; whether this is due to virus infection or to the diminution of nourishment from the top which

results from a congested, starch-clogged transport system, has yet to be determined.

Finally, attention should be drawn to cases of plants which do not show the symptoms in spite of their being infected. Symptomology of such disease-masking plants is not yet developed. In view of the fact that these constitute effective sources of infection, their detection with a view to their eradication is of paramount importance. Methods for detecting these plants, with reference to sandal spike, are now being developed at the Indian Institute of Science, Bangalore.

Cytological. [*M. J. Narasimhan.*]

During recent years, investigations on the cytology of plants affected by virus have shown that certain changes occur in the virus-affected cells. (i) The chloroplasts in the diseased cells have been found to undergo disintegration and in some cases have been reported to be loaded with starch, as in potato leaf roll and spike disease of sandal. (ii) In the case of the potato leaf roll, the phloem cells have been found to suffer from necrosis, involving the collapse of the cell walls, and affecting the function of the sieve-tubes. Phloem necrosis has been observed only in very few cases. (iii) The claims of some investigators that they have detected flagellate organisms in the tissue of the affected plants, have not been confirmed by other investigators. (iv) Cytoplasmic inclusions associated with animal virus diseases, such as rabies, fowl-pox, etc., which have been regarded to be of diagnostic value have been observed in some of the plants affected by virus. The nature of these inclusions was discussed, illustrating them with reference to the inclusions found associated with the spike disease of sandal, a serious virus disease prevalent in South India, especially in Mysore. The analogy of the inclusions found in sandal spike, with the Bollinger bodies of fowl-pox, in regard to staining reactions was pointed out.

Transmission.

Vector Transmission. [*T. V. Subramaniam.*]

It has been definitely established that insects play a very important part in the transmission and dissemination of virus diseases of plants.

The biological study of the subject has received considerable attention in foreign countries by numerous workers so that at the present day we have to record about 50 plants belonging to 27 Natural orders—some of them being of very great economic importance like sugarcane, potato, tobacco, etc.—known to be subject to virus attack of which many have been found to be transmitted by insect agency.

Among the insects noted as transmitting virus diseases in plants, insects with suctorial mouth-parts have been found to be more concerned than those with biting mouth-parts. Among the former, the family *Aphididæ* occupy the foremost rank as vectors of virus diseases with 27 to their credit.

A number of salient facts, *viz.*, the incubation period, period passed by the virus principle in the insect vector, presence of the inclusion body in the insect vectors, inheritance of the transmitting power by the insect vectors, length of time necessary for the insects to feed before they are capable of transmitting a disease, production of different symptoms when a virus is transmitted by insects and inoculation, etc., have to be considered in this connection.

Very little work has been done in India, excepting the work of Uppal showing the close association of the mosaic of (Chillies) Capsicum and Thrips.

In connection with a study of sandal spike, the sandal fauna of the spiked and healthy areas has been worked out. Attempts to find out the insect vector or vectors of the disease have not been a success as yet.

Artificial Transmission. [*M. Sreenivasaya.*]

Sap injection or inoculation and tissue transplantation are the two methods employed for transmitting virus diseases of plants. In many cases, *e.g.*, sandal spike, peach yellows, bunchy top of bananas, etc., sap injections have not transmitted the disease. A living support or carrier is perhaps necessary for maintaining the infectivity of the causal entity which appears to be rendered innocuous once it is freed from the live tissue. This is analogous to certain enzymes like *glycolase* which do not function when they are extracted from their associated tissues.

Tissue transplantation includes scion grafting, budding, patching and leaf insertions; it involves the insertion of a piece of infective tissue, freshly derived from a diseased plant at the susceptible region, in a manner that it will intimately fuse with the operated stock.

In transmission work, a due recognition of the susceptible region of the stock and infective tissues of the diseased plant is necessary. Ignorance of these facts have been responsible for the many failures of disease transmission cited in literature. If the infective material sap or tissue is not introduced into the susceptible region, the disease will not be transmitted. In the case of sandal spike, the disease cannot be transmitted if the infective tissue is transplanted at the root or into the wood, while successful transmission can be effected when the infective material is transplanted between the bark and the wood.

The technique of disease transmission in vogue is very crude as compared with those natural to vectors. Needle inoculation which represents the nearest approach to injection by aphids is still unsatisfactory. The natural intake of sap by the aphid is selective; laboratory preparations of sap constitute a mixture of various cell saps. The vector is further capable of injecting the infective sap into the susceptible region. The laboratory methods do not lend themselves to these requirements and sap injection in many cases are therefore unsuccessful, assuming for the moment that the role of the vector is to effect a mere mechanical but selective transfer of the infective sap.

An interesting case of tissue transplantation employed for disease transmission is that of leaf insertion in the case of sandal spike. Here is an instance of how by a judicious choice of the most infective tissue and the highly susceptible region, disease transmissions could be achieved with a very high percentage of success.

Reference may be made to root transmissions effected in the case of sandal plants where mutual parasitism is very common. A curious instance of a sandal plant which had made its connection with a grafted sandal plant getting spiked before the latter exhibited the symptoms, has been noted.

Properties.

"In Vitro" Cultivation of the Virus Principle. [*S. V. Desai.*]

It was found that the virus of sugarcane mosaic does not act as bacteriophage on organisms associated with the pest or present in the soil. Attempts to isolate organisms from diseased tissues on special nutrient agar, resulted in the growth of transport plaque-like colonies of a pleomorphic character. Healthy tissues similarly treated did not yield any organism. Subsequent culturing on agar and in broth did not affect their morphological characters. It was not found possible to free the organisms from the bacteriophage supposed to be associated with them.

A suspension of the organism was treated with a small inoculum of the virus, and incubated for five days. The filtrate obtained after passing the culture through a sterile filter candle was used for inoculating a fresh suspension of young organisms. Several passages of the virus were thus carried out to see if the virus multiplied during the serial transfers.

Inoculation experiments for the reproduction of the disease were carried with the suspension of these serial transfers. The inoculum used contained the virus principle diluted to $1 : 10^{16}$, $1 : 10^{30}$, $1 : 10^{44}$, far outside the limits of infective dilutions. The inoculated plants reproduced the original symptoms of the disease showing thereby that the virus principle multiplied *in vitro* either with or at the expense of the organism.

The same type of organisms were reisolated from the plants in which the disease was produced artificially.

Bacteria in Relation to Virus Diseases. [*N. V. Joshi.*]

The failure to get uniformly successful inoculations from organisms isolated from plants affected with some of the more common forms of virus diseases was regarded as proof that the diseases were not of bacterial origin and this has deterred a systematic investigation of the diseases from the bacteriological side.

However, ideas about the life cycle and morphology of bacteria under different cultural conditions have changed and are changing. Not only have many bacteriologists established that bacteria pass through a life cycle and under different conditions may exist in different visible forms, but recently Hauduroy in 1929 and Hadley in 1931, by adopting new methods, have been able to show a filterable stage in the life-cycle development of bacteria, and Swezy and Severin (1930) have shown indications of the existence of filterable forms of bacteria in the beet-root affected with curly top disease and the leaf-hopper that transmits the curly top of beets.

In the bacteriological laboratory at Pusa the mosaic diseases of several plant hosts have been studied (1931 and 1932) and cultures of bacteria from different plants affected with mosaic have been successfully isolated. Inoculation experiments with some of these cultures have been successful in reproducing all the symptoms of the virus diseases. In studying the cultures of these bacteria, the life cycle of the organisms was tried to be followed. After filtering the cultures through L-3 candles sometimes a growth could be observed and the slides were made from the smallest granules to the usually larger sized organisms. One of the organisms that was being examined happened to be a flagellated bacterium; on staining, the small granules were found bearing flagella in the same way as the larger sized bacteria. This is perhaps the first time that such an observation is recorded. The fact that the growth in the filtrate when inoculated on agar gives the same kind of growth as the original culture shows that there is a filterable stage in the bacteria that have been studied.

There appears to be very little difference between visible bacteria and the viruses. The dividing line between them is one of size only. It is necessary to examine the possibility of the existence of filterable forms of bacteria more thoroughly as one of the possible methods of arriving at a solution of this perplexing problem of the nature of virus diseases.

General. [*A. V. Varadaraja Iyengar.*]

Absence of easily recognizable and usually associated plant pathogens like bacteria, fungi and protozoa in virus-infected plants led to the suspicion that the diseases are caused by soil deficiency: the effect of fertilizers was therefore investigated by earlier workers in the case of peach yellows, tobacco and tomato mosaics, and sandal spike, but without any significant results.

Moisture and ash contents of diseased plants are generally lower than those of healthy, thus pointing to a poor absorption of the essential nutrients from the soil. Among the ash constituents, lime is conspicuously low in the diseased leaves of peach and sandal. This deficiency could not be traced to the soil.

Abnormal starch accumulation appears to be a general characteristic of all virus-infected plants, *e.g.*, tobacco mosaic (Wood and Hunger), potato leaf roll (Esmarch), spinach blight (True and Hawkins), false blossom of crawberry, peach yellows and sandal spike. A detailed study of the starch content of spike leaves of sandal has shown that it increases with the progress of the disease. In early stages, however, the twigs have been found to contain more starch than leaves. Esmarch ascribes this phenomenon to defective translocation of photosynthetic products of the leaf. Neger, in his study of potato leaf roll could not correlate the degree of rolling with starch content.

Significant conclusions cannot be drawn with regard to the other carbohydrates occurring in the diseased condition.

A physico-chemical study of the tissue fluids in the case of sandal spike and curly top of sugar beets, has been carried out.

Nitrogen Metabolism. [*V. V. Sreenivasa Row.*]

Significant changes are brought about in the nitrogen metabolism of all virus-infected plants. In his studies on the mosaic of sugar beets, Bonequet drew attention to this aspect of the problem. Nitrites and ammonia nitrogen were found to occur in larger quantities in the diseased leaves. He concluded that the internal bacterial flora were responsible for the reduction of nitrates to nitrites and ammonia; these results found confirmation in his work on potato mosaic. A systematic study of the nitrogen distribution in the tissues of healthy and blighted spinach was carried by Jodidi, Kellog and True, who found higher

concentrations of nitrite and ammonia in the diseased condition.

In the case of sandal spike, however, a study of the nitrogen distribution has revealed (*a*) an increase in the water soluble nitrogen, (*b*) a higher concentration of the basic fraction, and (*c*) an increase in the amino-nitrogen. Further analysis of the basic fraction has shown an abnormal amount of histidine in the diseased condition, leading to the significant suspicion that histidine is getting decarboxylated with the production of histamine, a compound known to inhibit the growth of roots. The low percentage of arginine in the basic fraction in spiked leaves is equally noteworthy, as it explains the general suppression of reproductive activity with the progress of the disease.

Enzymes. [*B. N. Sastri.*]

Significant disturbances in the enzyme make up of plant tissues accompany the onset of virus diseases. It was believed at one time that the causal entity of virus diseases is of the nature of an enzyme, a theory which has recently been supported by the work of Vincent on tobacco mosaic.

Diastases and oxidases are the two groups of enzymes that have received wide attention; an increase in diastatic activity has been found in the diseased leaves of sandal, and *Dudonea viscosa*. High oxidase and a low catalase activity have been recorded for most of the mosaics. The curly top and curly leaf of beets also exhibit a high oxidase activity.

The disturbance in the enzyme balance has been brought about by subjecting the organism to unfavourable environmental conditions. Drought and over-watering, for example, have been found to develop abnormally high oxidase activity. Starvation of cells has been found to stimulate the development of enzymes.

High diastase activity, optimum reaction and lower moisture content of the metabolic fluids are significant factors influencing rapid synthesis of starch in the diseased leaves. The occurrence of the liquefying component of the diastase in low concentration hinders the rate of translocation of the products of photosynthesis leading to an abnormal accumulation of starch in the diseased tissues.

The high percentage of amino nitrogen present in the tissue fluids of the spike leaf, suggestive of the enzymatic degradation of the leaf proteins, points to a greater activity of proteases in the diseased tissues. As in the case of other virus-affected plants, a high oxidase activity is shown by the tissues of spiked sandal. Respiration studies show that a high oxygen intake and low carbon-dioxide output are characteristic of diseased tissues. It is, therefore, clear that the oxidation-reduction mechanism is upset in the pathological condition and this explains the occurrence of mannitol and accumulation of organic acids. The discussion centres round the concentration of respiratory pigment cytochrome. An insufficiency of this favours fermentative processes leading to the formation of alcohols. Incomplete oxidation of sugars results in the production of free acids which accumulate in the tissues owing to the lack of sufficient quantities of lime for neutralization.

Control Measures. [*A. V. Varadaraja Iyengar.*]

Control measures consist of (1) introduction of resistant varieties, (2) removal of infection centres, and (3) elimination of the carriers of infection.

The existence of resistant varieties is known and can be evolved either by selection or hybridisation. In the case of parasitic plants like sandal the possibility of building up resistance through host plants may be indicated.

The basic control method must aim at the eradication of the sources of infection. This requires a decisive method for diagnosing the disease which, in the case of sandal, is complicated (1) by the fact that the plant under certain environmental conditions exhibits symptoms analogous to spike, and (2) by the presence of disease-masking plants. The symptomology of these two classes of sandal plants are being worked out.

In practice a complete eradication of the diseased parts of the plant necessary for the control of infection is difficult and expensive, but this is the only method adopted in the case of the diseases of the peach and the leaf roll of potato. A similar method has been adopted in the case of sandal spike but with this modification that the plant prior to its uprootal is treated with an arsenical preparation, "Atlas", which has greatly facilitated the operation.

Eradication of wild hosts of the same species has been found necessary in the case of the cucumber mosaic.

Discussion.

Referring to the studies of transmission by insect vector, Mr. A. V. Varadaraja Iyengar spoke on the work that is being carried out at the Indian Institute of Science, Bangalore, by Mr. Cedric Dover and his collaborators in connection with the spike disease of sandal. Elaborate work on the sandal fauna, although forming a unique contribution to South Indian Entomology, has not yet yielded any positive result by way of establishing the vectors.

Dr. Gilbert J. Fowler speaking on the work carried out at Pusa, pointed out that the danger of organisms growing through the filter candles is great unless scrupulous attention is devoted to aseptic conditions of experimentation. This factor is generally overlooked.

Mr. B. N. Sastri was of opinion that the bacterial nature of the virus principle can be disputed on the basis of its resistance to several powerful cytolysing agents such as toluene and acetone.

Prof. R.H. Dastur, referring to the physiological studies, said that all the observed results are consequential to the virus attack and inasmuch as they do not give any clue as to the cause they are only of limited value.

B. N. SASTRI.
M. SREENIVASAYA.

The Science of Optics in the Service of Chemistry.

THE Indian Chemical Society held its ninth annual meeting at Patna on January 3, 1932, when Prof. B. K. Singh, the retiring President, delivered a very interesting address. Dr. Singh prefaced his address with a brief account of the origin and development of the Indian Chemical Society during the years 1924—1932. The increase in the number of fellows (from 101 to 360), subscribers, and exchange journals, the larger size of its own journal and the Society's general financial conditions all showed a steady progress. The Society conferred its honorary fellowship on two eminent scientists, Prof. A. Sommerfeld and Sir C. V. Raman and arrangements have been made to present to Sir P. C. Ray, in celebration of his 70th birthday, a commemoration volume with an address, as a token of esteem and love from the Society. The President concluded this part of the address with an appeal for funds for the permanent housing of the Society and the provision for a whole-time paid editor.

The main address was a lucid exposition of optical methods in the service of chemistry which contained an excellent summary of the Professor's own work carried out at Ravenshaw College, Cuttack, on the optical dispersion of organic compounds. Refraction, absorption and optical activity have been studied by chemists for over a century and have rendered signal service to the progress of chemical theory. During the early days of spectroscopic work, the interest of the chemist lay chiefly in the assignment of spectral lines to elements and compounds responsible for them. Bunsen, Kirchoff and Herschel were among the notable pioneer investigators in this field. The material to be examined is introduced into an arc or into a condensed spark and the spectrum photographed over the wave-length range 7000–2000 Å. Spectroscopic methods for quantitative analysis have been an attractive field of research by chemists since the days of Hartley in 1884. The most satisfactory methods in this field are due to de Gramont and Meggars who utilized the variation in intensities of spectral lines. The methods are of special value when estimating abnormally small quantities of material. The absorption curves of substances have been widely used in elucidating the structure of compounds. They form a very important source of information we possess on questions of structure.

Raman spectra, the most recent discovery, promise to provide more accurate knowledge of the structure of molecules than any other spectral method. On passing a beam of mono-chromatic light into a liquid and observing the scattered light, in addition to the simple line frequency present in the original beam, Raman found a number of very faint lines, the frequencies of which are related to the frequencies of vibration of atoms in the molecule which does the scattering. Raman spectra have been observed with gases, liquids, crystals, or glassy solids. One of the many interesting results arising out of the application of Raman spectrum is the detection of the inhomogeneity of hydrogen.

The phenomenon of optical activity depends upon the property which certain substances possess of imparting a twist to the plane of the polarization and was first discovered by Arago in 1811. Biot's pioneer work on the optically active organic compounds led to the discovery of molecular disymmetry by Pasteur. It was recognized by Biot quite early that optical dispersion is a more characteristic property of substances than optical rotatory power. He divided active substances into two types according as they obeyed the law of inverse squares or showed deviations from it, but it was not long before he began to suspect that his law was not rigorously exact. In 1898, Drude making use of the electronic theory of radiation expressed the variation of rotatory power with wave-length by means of the general formula $\alpha = \Sigma \frac{k_n}{\lambda^2 - \lambda_n^2}$. Lowry showed that these equations are adequate to determine the exact forms of the dispersion curves. He called the dispersion simple when one term of Drude's equation is sufficient and complex when two or more terms are employed. Drude's equation applies only to transparent media and not to absorption regions studied by Cotton in the region of the Cotton effect. The experimental determination of optical dispersion has been rendered easy by the introduction of new sources of light such as the enclosed mercury and cadmium arc lamps. For work in the ultra-violet region, the methods of Lowry and of Cotton and

Descamps are the most noteworthy. Lowry has also developed a method for the infra-red region, using a Nernst lamp to illuminate the infra-red spectrometer which carries a thermopile in its eyepiece. A large number of secondary alcohols, oxymethylene camphors and their condensation products with aromatic amine compounds show simple dispersion proving that the type of dispersion is independent of the number of asymmetric carbon atoms. The dispersion of camphor, monoacetyl *p*-phenylene-bis-amino camphor and other derivatives of camphor is complex and show the three characteristic anomalies—an inflection, a maximum and a reversal of sign. One more example of the importance of optical methods in chemistry is the recent announcement of Kuhn, Braun and Freudenberg of instances of successful asymmetric synthesis by application of circular dichroism. By exposing the ethereal solutions of racemic ethyl α-bromo-propianate and α-azido-propionic acid, to light λ=2800-3000 Å, optically active substances have been obtained. Though the range of activity obtained is small, the fundamental problem of asymmetric synthesis appears to have been solved in principle.

B. S.

Research Notes.

A Manometric Analysis of the Metabolism in Avian Ontogenesis.

J. NEEDHAM has determined by manometric methods (*Proc. Roy. Soc. Lond.*, Ser. B. **112**, No. 775) the normal respiratory quotient of the chick embryo in the first week of its development and finds that for the first two days the respiratory quotient is more than unity while from the second to the sixth day, it is nearly one. After the sixth day it tends to fall to 0·6. The action of certain reagents on the respiratory activity of the blastoderm, the embryo and the yolk-sac has been determined. It is found that flouride has an inhibiting action on the respiration of the embryo only in higher concentrations while the respiration of the yolk-sac and the blastoderm is affected even by lesser concentrations. The inhibition, however, is reversible, by addition of lactate. The action of iodoacetate is similar even with milder doses. Only partial inhibition without any change in the respiratory quotient is noticed with phenyl-methane. Malachite green and cyanide are comparatively very strong in their action.

The Solubility of Water in Granite Magmas.

THOSE interested in the study of the volatile constituents of magmas, which are known to play an important part in volcanology, ore-deposition and other igneous phenomena, will welcome the paper on "The solubility of water in Granite magmas"—recently published in the *American Journal of Science* (Dec. 1931). The author believes that many debatable problems of volcanology will be readily solved if we know how water dissolved in magmas behaves at different temperatures and pressures. A detailed account of the experimental work done in the investigation of this problem has been given in the paper and data are presented on the solubility of water in granite glass as a function of pressure from 500–4000 bars at 900°C. and as a function of temperature from 600°–1200° at 980 bars. Reasons are presented for considering the possibility that granite magmas may have had a relatively high water content.

Electro-Optics: Part Absorption in the Region of Soft X-Rays

[F. G. Chalklin and L. P. Chalklin, *Compt. Rend.*, 1932, 374.]

RAY has measured with $K\alpha$ (Cu), Ni $K\alpha$ some diffuse rays with lowering of frequency corresponding to the spectral terms of the absorbent.

Lines similar to those obtained by Ray have been obtained by Majumdar who employed monochromatic radiations $K\alpha$ (Ni), $K\beta$ $K\alpha$ (Fe) the absorbents being nitrogen, carbon and aluminium. Further Bhargava and Mukerjee by passing $K\alpha$ (Cu) through paraffin have obtained a diffuse line whose frequency is less than that of the incident radiation by $\Delta\nu$=R. This effect has been attributed to partial absorption of quantum by an atom of hydrogen from which an electron has been completely expelled. These savants by passing the $K\alpha$ (Ag) radiation through a foil of Ni have also observed a sharp discontinuity on the short wave-length side. The difference between the $K\alpha$ of silver and

the sharp discontinuity has been found equal to the energy of the K absorption discontinuity of nickel.

On the contrary, Lindsay, Alichanow and Arzimowic as well as Thibaud and Cork have not obtained any displaced line.

All these contradictory experiments have been performed with waves having wave-length of the order of about 1 Å. We have thought of looking for the modified line in the region of soft X-rays with the aid of a technique which is very different from those of the savants cited above.

By using a vacuum spectrograph with a grating in which X-rays were incident tangentially, we have examined the spectra of many elements. On the majority of plates one observes the $K\alpha$ line of carbon. The carbon is deposited on the anticathode by decomposition of the vapour of carbides of hydrogen which are liberated from joints and seals of the spectrograph. We find upon the plates where the $K\alpha$ line of carbon is very intense a line which is very diffuse on the long wave-length side. This appears whether the anticathode is made up of platinum, palladium, or copper. The visual inspection of numerous plates reveals that the intensity of these lines increases with that of the $K\alpha$ line of carbon and moreover it is seen very clearly upon the plates on which there is no other radiation except that of carbon. One can conclude that the effect is due to carbon. The diffuse character of the line indicates that we have not to deal with ordinary line, because such diffuse character is not observed in the usual X-ray lines except in the case of $K\alpha$ line of still lighter elements, and the wave-length of the line shows that it cannot be due to these elements.

We have observed the effect in the second order. The effect has also been observed with the aid of two gratings ruled with Siegbahn's machine of which one has got 600 lines, the other 300 lines per mm. It has been obtained under different angles of incidence and it is clear that the effect is not due to any fault in the adjustment of the apparatus.

The wave-length 51Å corresponds to 242 electron volts. It is less than the excitation voltage of $K\alpha$ line of carbon by 35 volts. It is evident that the ray cannot be due to any transition in an atom of carbon but is due to a secondary process.

By the photoelectric method it has been found that the ionisation potential of L level varies from 35–40 volts and by the Spark Spectrum method of Millikan a value slightly higher than 34·2 volts has been found. We arrive at the conclusion that our diffuse line is due to the expulsion of an electron at the L level by a quantum of radiation $K\alpha$ with the loss of a part of its energy. If one admits the correctness of the process, $h\nu$ of the modified line should be $h\nu K\alpha - W_{L\to\infty}$ This frequency corresponds to the energy 242 volts which is in very good accord with the observed value. That there is a veritable evidence of absorption is the proof that we obtained also the discontinuity of carbon on the same plate. The wave-length which we obtain agrees very well with the first determination by Thibaud, *viz.*, 284 volts. It is probable that this discontinuity is the result of a process where a K-electron passes to the first empty level at the exterior of the atom. This inclines us to the supposition that it may be the passage of an electron from the occupied L shell to the next vacant level (due to $K\alpha$) which gives rise to our line.

It is necessary to note that in the case of discontinuity of absorption, the incident radiation forms a continuous spectrum, while the exciting radiation of our modified line is monochromatic. Nevertheless, an effect due to a shifting by this space is admissible. In such a manner one can explain easily the broadening of the $K\alpha$ line of carbon in the direction of the long wave-length as observed by Prins, as well as by ourselves. On our plates we observe a blackening of plates beginning from the $K\alpha$ ray of carbon up to the diffuse line.

We have also to notify the discovery of a further discontinuity at 39·7Å corresponding to 311 volts. We believe that it results from the complete expulsion of the electron and it gives us a correct measure of the value of K level. We conclude that the excitation potential of $L\to\infty$ is equivalent to 311 — 277 or 34 volts, which is in good accordance with the observed values.

Studies on the Hypophysectomised Ferret.

MARGARET HILL AND A. S. PARKES in a series of three interesting articles (*Proc. Roy. Soc. London*, Ser. B, **775**, 1932) describe the surgical technique for hypophysectomy, the spermatogenesis of the thus treated individuals and also the effect of post-coitus hypophysectomy on ovulation and the development of the corpus luteum. The

authors describe in the first part the methods adopted in exposing the pituitary body, after anaestethising the ferret; the basisphenoid bone is drilled and the pituitary is removed by the application of a glass suction pippette. A series of precautions to ensure a successful operation are reported. The second part deals with the spermatogenesis in individuals that underwent the operation. The testes of the hypophysectomised ferrets were removed at different periods and were sectioned and studied. The testis of a normal ferret was also studied as a control The conclusion of the previous workers like Smith, Reichert and Wislocki is that the reproductive tract in the male atrophies after hypophysectomy. The observation on the ferret is in accordance with the results of the previous workers. There is a definite regression characterised by decrease in weight of the testis and by aspermatogenesis. The experimental regression is about three times as rapid as the normal decline into anaestrum. The ferret is definitely known to ovulate after copulation. The effect of hypophysectomy on the animals is to inhibit the growth of the corpus luteum and the animals fail to become pregnant after hypophysectomy before ovulation.

A Genetical Formula for the Inheritance of Intelligence in Man.

DR. C. C. HURST has published (*P. R. S.*, B, **112**, 775, 1932) an interesting paper on the results of his investigations on the inheritance of the natural mental ability of a large number of Leicestershire families and also on the independent statistical material presented by F. A. Woods of Boston. These investigations using the statistical methods were first undertaken by Galton and his method and conclusion have been greatly elaborated by Pearson in England and Woods of Boston in America. Dr. Hurst's results are best given in his own words:

"Two diverse sets of material have been used in the investigation of the inheritance of natural intelligence in man. (1) The L. F. data of 194 Leicestershire families consisting of 388 parents and their 812 offspring, individually studied by the author. (2) The R. F. data of the Royal families of Europe consisting of 212 families including 424 parents and their 558 offspring, statistically studied by Woods (1906). The concept of general intelligence is defined. Following Galton (1869) and Woods (1906) individual parents and offspring have been graded for intelligence, on their general mental achievements, in 10 equal grades, from the highest grade 10 to the lowest grade 1. The grades are characterized as follows:— 10, illustrious; 9, eminent; 8, brilliant; 7, talented; 6, able; 5, mediocre; 4, dull; 3, subnormal; 2, moron; 1, imbecile; (0, idiot). Equivalent juvenile gradings in terms of I.Q. are estimated at 20 I.Q. per grade, *e.g.*, 200 I.Q. =grade 10, 100 I.Q. =grade 5, 20 I.Q.=grade 1.

"The most frequent (grade 5) parents were found to be of three genetical types NN, Nn and nn, in which N is a dominant gene for normal mediocre intelligence (grade 5) and nn is a recessive pair of genes for abnormal variable intelligence in the presence of which any of the ten grades of intelligence may be expressed. The 10 grades of intelligence are provisionally referred to the action of five pairs of minor genes Aa....Ee in the presence of the major pair nn. The dominant minor genes A....E act as equal and cumulative increasers of intelligence while the recessive minor genes a....e act as decreasers. In the presence of the dominant major gene N(NN or Nn) the minor genes Aa....Ee are inactive.

"On this basis the genetical formula for the inheritance of intelligence is hexagenic, consisting of 1 major and 5 minor pairs of genes. It may be expressed in 729 genotypical forms of which the most heterozygous form is [Nn *plus* (Aa *plus* Bb *plus* Cc *plus* Dd *plus* Ee)]."

It is concluded that the genetical formula proposed fits the diverse data sufficiently well qualitatively to be used as a working hypothesis for other families and populations on which it should be tested quantitatively on a large scale by systematic and co-operative research.

The Dartmoor Granites.

THE recent paper on "The Dartmoor Granites: their genetic relationships" (*Q.J.G.S.*, **88**, May 1932) is perhaps the most important of the series of papers published by A. Brammal and H. F. Harwood on the Dartmoor Granite—the largest of the west of England Complexes. The paper gives nearly a hundred analyses of the various types of associated rocks in this complex and all this analytical evidence is made to throw some light on the problem of granite

variation as a criterion in field mapping and as an aid to the tectonic interpretation of the Dartmoor Complex. "The outstanding feature of the article is the intensive character of the work done in demonstrating both assimilation as a fact and the *selective* nature of the reaction mechanism fundamental to the process and in establishing a bigeneric cause for the variation; the latter recapitulates phenomena prone to be regarded as due to differentiation alone, whereas it is attributed, in the Dartmoor case, to differentiation in alliance with assimilation of shales and basic igneous rocks." From their studies in this field, the authors have also discussed the problem of the origin and nature of "initial granite magma", and it is their belief that while it may be possible that granitic rest-magma may be evolved by differentiation from basaltic parent magma, this process alone, unaided by either assimilation or palingenesis, is inadequate to produce granite in batholith-bulk.

Observations on the Immature Stages of some Indian *Psyllidæ* (*Homoptera : Rhynchota*).

[Rahman, K.A., *Ind. Journ. Agric. Sci.*, **11**, 4, 358, 1932.]

THOUGH the Psyllidæ are an important group of insects from the economic viewpoint, very little is known of their biology, and common Psyllid pests are generally unidentifiable in the pre-imaginal stages. Mr. Rahman's paper is, therefore, to be welcomed as a small but useful contribution to the identification of immature Psyllids. He describes the stages of five Indian species, and offers various observations on bionomics. It is to be hoped that Mr. Rahman will continue his studies to the point of a monograph on Indian Psyllidæ.

The Institution of Engineers (India).

THE Institution of Engineers (India) was started in India about twelve years ago and is being run on lines similar to other professional Institutions in England and other Western Countries. It is composed mostly of engineers who are actually engaged in the practice of the profession. Many of the members are eminent leaders in the profession. Its headquarters are in Calcutta and a number of local centres are established in different parts of India. The Institution generally holds its annual sessions in different centres in India, and professional papers contributed by the members are read and discussed during those sessions. The privilege of membership to the Institution is a valued one. New entrants, unless considered by the Council as otherwise fully qualified, are subjected to an examination similar in scope and character to the B.E. Degree examination of an Indian University. In pursuance of this the Government of India have delegated to this Institution the onerous responsibility of controlling the standard of efficiency in all the Engineering Colleges in India and Burma, and the question of recognition of the B.E. Degree of the Mysore University was under its consideration for over four years. The President of the Institution inspected the College about a year ago.

Although Bangalore was not a centre, still the Mysore University extended an invitation to it in the year 1930 to hold its next session in Bangalore, but it declined to do so as there was no local centre in Bangalore. The invitation to hold this year's session in Bangalore was again repeated and the Institution agreed to do so on the undertaking of Mr. S. H. Lakshminarasappa, former Principal of the Engineering College, to make all necessary arrangements for the meeting. Mr. Lakshminarasappa thus took the entire responsibility and left no stone unturned to make the function a grand success. He deserves to be warmly congratulated for the untiring zeal and energy with which he shouldered and discharged his responsibilities.

The sessions lasted for four days and two meetings were held in the Daly Memorial Hall on the 16th and 17th January 1933 and two excursions were made to Sivasamudram and Krishnarajasagara on the 18th and 19th idem.

A dinner was held by the Institution at the West End Hotel on the 16th night and about sixty covers were laid. His Highness the Yuvaraja of Mysore was the Chief Guest of the evening. The President, Dr. Jardine, in proposing the health of His Highness the Yuvaraja, gave a brief history of the Institution and announced the recognition of the B.E. Degree of the Mysore University by the Institution. His Highness then made a short and appreciative speech and made a handsome donation of Rs. 2,500 towards the Building Fund of the Institution.

On the 16th afternoon and on the 17th morning some local visits were undertaken by the members to the Indian Institute of Science, the Porcelain Factory and Soap Factory, and a business meeting was held and a valuable paper on "Tunnelling in connection with the Uhl River Hydro-Electric Scheme" was read by Mr. N. V. Darofeeff, who is an Associate Member of the Institution. The meeting was well attended and a number of members took an active part in the discussions which followed.

The Mysore Engineers' Association were at home to the Members on the 17th evening and the elite of the town were present.

This opportunity was taken to form a local centre of the Institution of Engineers (India) at Bangalore, as many of the members of the Mysore Engineers' Association have come forward to join the Institution, because of the substantial financial help promised by Government.

The members expressed themselves very pleased with all that they saw in Mysore.

V. G.

Science News.

ASTROLABES are not as generally available for study in the museums of the world as their scientific importance and artistic qualities would merit, but all who may desire to become better acquainted with this instrument in its various forms are now given the opportunity. Subscribers are invited for a comprehensive work, entitled *The Astrolabes of the World*, based upon the series of instruments in the Lewis Evans Collection in the Old Ashmolean Museum at Oxford, in the British Museum at S. Kensington, and in several other public and private collections in India and America. The early Greek Treatise on the Astrolabe, by Philopon, and the Syriac Treatise by Sabokt, both dating from the seventh century will appear in English for the first time. Illustrations are given of Chaucer's astrolabe, now clearly identified by the character of the rete as depicted in MSS., and many instruments contemporary with Columbus and Drake are figured; also several important examples made at Lahore.

No such history of any other scientific measuring instrument has ever been published. The subject is of fundamental importance to all students of the history of Indian and Persian astronomy and geography and surveying, and indeed to the History of Science generally, for it may truly be said that the astrolabe kept alight the torch of the scientific method of observation, and of computation of results, in many countries, and through many dark ages, when larger instruments and well-equipped observatories did not exist.

The complete work will be issued in two quarto volumes, containing over 600 pages and 155 plates, of which 12 are in Collotype, and 216 text figures.

The price to subscribers is ten guineas. Subscription forms may be obtained from Dr. R. T. Gunther, Curator of the Lewis Evans Collection, in the Old Ashmolean, Broad Street, Oxford.

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At the second annual meeting of the Society of Biological Chemists held at Patna, on the 3rd January, the following Office-bearers were elected for the current year: —*President*—Rai Bahadur Dr. Upendra Nath Brahmachari, M.A., M.D., Ph.D. *Vice-President*—Dr. Gilbert J. Fowler, D.Sc., F.I.C. *Members of the Executive Committee*—Prof. R. H. Dastur, M.Sc., F.L.S.; Prof. H. K. Sen, D.Sc., D.I.C.; Dr. C. V. Natarajan, M.B.B.S., D.P.H.; Rao Bahadur B. Viswanath, F.I.C.; Dr. P. E. Lander, M.Sc., D.Sc.; Mr. C. S. Rama Iyer, B.A.; Dr. K. C. Sen, D.Sc.; and Lt.-Col. J. A. Sinton, V.C. *Treasurer*—Dr. V. Subrahmanyan, D.Sc., F.I.C. *Secretary*—Mr. B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc.

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Under the auspices of the Medical and Veterinary Section of the 20th Indian Science Congress held in Patna, Dr. Igor N. Asheshov, Officer-in-charge, Bacteriophage Inquiry, Indian Research Fund Association, Patna, gave a demonstration of Bacteriophage. Dr. Asheshov explained the principles of the handling of bacteriophage and of preparation of bacteriophage mixtures for practical application.

The technique of isolation of bacteriophage from different sources was explained and shown. It was pointed out that the most important fundamental rule which must be observed in working with bacteriophage is to use all the precautions necessary for isolation and maintenance of cultures of bacteriophage in ultrapure state, *i.e.*, cultures containing one type of bacteriophage, non-contaminated with another type. The Type Test introduced by the author insures the necessary control of the purity of such cultures. The application of the described technique makes a rational basic study of the properties of bacteriophage possible.

The strict application of the following rules in preparation of bacteriophage mixtures for prevention and treatment were recommended.

The mixture must contain all the known types of corresponding bacteriophage, as each type compensates the action of another.

The properties of the races of bacteriophage used, and particularly their virulence, must be thoroughly studied. This investigation at the present time is put on a rational basis by application of the Virulence Test introduced by the author.

The races of bacteriophage used for preparation of bacteriophage mixtures must not be altered by laboratory procedures, but must possess all the properties of bacteriophages met with in Nature. This is achieved by passing bacteriophage races through human organism and by the use of only freshly isolated unaltered bacterial cultures.

The mixture of bacteriophages must contain sufficient number of corpuscles of each type of bacteriophage. There must be at least 1×10^9 of each of the main types of bacteriophage in 1 c.c. of the mixture.

* * *

The Eighth (Jubilee) Conference of the Indian Mathematical Society was opened on the 21st December by His Excellency the Governor of Bombay, with an encouraging and sympathetic speech. The forenoons of 22nd and 23rd were devoted to the reading and discussion of papers; the afternoons were devoted to a discussion on the teaching of Mathematics in primary and secondary schools, in which the local teachers took part, and a discussion on the teaching of Mathematics in the University. In the latter the question of the place of rigour in University teaching figured prominently, and a suggestion to include actuarial science among the optionals for the B.A., made by Mr. L. S. Vaidyanathan, Actuary, received a certain amount of support. There were three popular lectures on the evenings, namely:

"The Present Crisis in Dynamics" by Prof. Saha.

"The Nature of the Continuum" by Dr. R. Vaidyanathaswamy.

"Mathematics and Religion" by Rao Bahadur P. V. Seshu Aiyar.

The Celebration of the Silver Jubilee on the 24th was presided over by Dr. Mackenzie, Vice-Chancellor of the Bombay University. An address was presented to Prof. M. T. Naraniengar who served as the first editor of the *Journal of the Indian Mathematical Society* for over a period of twenty years. Speeches were made by the various foundation members who were present on the

occasion, referring to the history and work of the Society.

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The attention of the authors of the note "On the Breeding Habits of *Gecko verticillatus*" published in *Current Science* (Vol. 1, No. 6, pp. 164-165), is invited to a previous communication on the same subject recorded in the *Proceedings of the Indian Science Congress* (1931), and we believe that omission to refer to this earlier work is due to oversight. Dr. B. K. Das, Professor of Zoology, Osmania University, who, as senior author, communicated a note first to the Zoology Section of the Indian Science Congress held in 1931 at Nagpur, further refers to this work in the list of literature he cites in *Anat. Anz.*, Vol. 73, No. 14/16, February 1932.

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In connection with an article of Prof. I. Traube (*Koll. Zeit.*, **59**, 136, 1932) in which he refers to a paper by Prof. Satyendra Ray (*Koll. Zeit.*, **56**, 165, 1931) on the constants in Van der Waals' equation, and says that the approximate constancy of the ratio of the constants *a* and *b* had been noticed long before by himself in the case of liquids (*Zeit. f. Phys. Chemie*, **68**, 289, 1909) and by Prof. Bodenstein in the case of gases, Prof. Ray writes to inform us that his work was done independently of Prof. Traube's results and with the opposite purpose, *viz.*, to show the unsuitability of Van der Waals' equation, whereas Prof. Traube considered it to be a most important equation of state. With regard to Prof. Bodenstein, Prof. Ray writes that in a letter to him Prof. Bodenstein had pointed that a/b could not be a constant considering the fact that it is zero for hydrogen, helium and neon while Dewar had found a difference of 40% between ethylene and ammonia. Prof. Ray also points out that he has newly developed a theory in which it is shown that the ratio a/b exhibits atomicity apart from the approximate constancy which was noted by Prof. Traube in the case of some liquids containing carbon at 0°C. but was not theoretically deduced. Such questions of priority, however, are of no more scientific interest, writes Prof. Ray, and it may be more profitable to wait for the results that follow from his new theory.

* * *

Addressing the Deccan Merchants' Association in Bombay Sir M. Visvesvaraya laid stress on the imperative need for initiating new industries as the most effective means of relieving the present economic distress in the country. He discussed the possibilities of the future and showed how, with the necessary state aid and local effort, various types of major, medium and minor industries can be started. He suggested the creation of a National Economic Council with head-quarters at Delhi and similar organizations at various provincial centres for the purpose of conducting industrial surveys and promoting new industries. It is gratifying to note that the machinery proposed by Sir Mokshagundam is similar to the one outlined in an earlier issue of this Journal (*Curr. Sci.*, **1**, 95, 1932).

* * *

Is man ethically fit for the gifts of science? This is the subject of a thoughtful article by Prof. D. D. Kanga (*Jour. of the Univ. Bombay*, Vol. I, Pt. II, 1932), who, after showing how science has fulfilled human expectations, adduces evidence to prove how man's selfishness renders such gifts unavailable to his brethren. The motto of science is service combined with truth and it should be the endeavour of every university to teach its students a scientific outlook on life which would not only enable the latter to face the various every-day problems but also inspire them with the will to share the gifts of nature with the others, of whatever race and country, who are deficient in them, and for the common good of all.

* * *

At the invitation of the Annamalai University, Rao Bahadur B. Venkatesachar, M.A., F.Inst.P., will deliver a series of five lectures on "Atomic Nucleus and Hyperfine Stucture of Spectral Lines" commencing from the 11th February. The lectures are divided as follows:—Rutherford's atom model and Bohr's derivation of Balmer's formula: Sommerfeld's elliptic orbits and fine structure of Balmer lines; Quantum numbers and spectral terms—Selection rules; Collisions of the first and second kinds—Resonance potential and Ionisation potential—Experimental technique; Interaction between radiation and matter—The Compton and Raman Effects; Recent work on atomic nuclei including hyperfine structure of spectral lines.

* * *

Silica and Soil Nitrogen.—Mr. A. SRINIVASAN of the Department of Biochemistry, Indian Institute of Science, Bangalore, writes:—Although a large part of modern agricultural research relates to nitrogen transformations in soils, yet very little systematic work has been carried out to determine the accuracy of the methods employed in such investigations. My recent studies supported by the earlier ones of Bal in the case of black cotton soils (*J. Agric. Sci.*, **15**, 454, 1925), have shown that the various modifications of the Kjeldahl method involving digestion of dry specimens with concentrated sulphuric acid lead to inaccurate estimates, the error being, in some cases, as high as 25 per cent. The defect in the above technique is due to the formation of protective coats of silica around unattacked soil particles which thus render the digestion incomplete. The above difficulty can, however, be overcome and accurate values obtained by pre-treating soils with hydrogen peroxide, water, aqueous solutions of different acids, bases or salts, or volatile solvents. A modified method leading to (*a*) quicker and smoother digestion and (*b*) higher and more consistent values than by any of the present official methods has been developed and will form the subject of an early communication to the *Indian Journal of Agricultural Science*.

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We acknowledge with thanks the receipt of the following:—

"Nature"—Vol. 130, Nos. 3289-3297.

"Chemical Age"—Vol. 27, Nos. 698-705.

"Journal of the Indian Chemical Society"—Vol. 9, Nos. 9-11.

"The Indian Forester"—Vol. 58, No. 12.

Scientific Notes of the Indian Meteorological Department—Vol. V, No. 48:

"On Some Characteristics of the Tropopause and Upper Troposphere over N. W. India", by N. K. Sur and J. C. Roy.

Scientific Notes of the Indian Meteorological Department—Vol. V, No. 50:

"Inversions of Lapse Rate of Temperature over Karachi" by A. S. Hariharan.

Scientific Notes of the Indian Meteorological Department—Vol. V, No. 51:

"A Preliminary Study of Rainfall at Quetta" by A. K. Roy and R. C. Bhattacharya.

Annual Report of the Imperial Institute of Veterinary Research.

Memoirs of the Indian Meteorological Department "On Evaporation" by S. K. Banerji.

Reviews.

THEORY OF ELECTRICITY AND MAGNETISM. By Prof. Max Planck. Translated by Henry L. Brose, M.A., D.Phil. (Oxon.), D.Sc., Macmillan & Co, Ltd., London, 1932.

This is an English translation of the third of a series of five volumes on theoretical Physics by one of the acknowledged leaders of thought in Modern Physics. The book aims at giving a unitary exposition of the Field Theory of Electricity and Magnetism and as such its arrangement and treatment of the subject are different from what are usually found in English treatises on the same subject.

English writers usually follow Maxwell as regards arrangement and method. Electrostatics, magnetism, current electricity and electrodynamics are generally treated as separate and independent branches of science with their own special laws. They usually begin with the Coulombian Laws of force based on the hypothesis of action at a distance and though the Field Theory finds a place in every book it occupies usually a very subordinate position. Emphasis is, on the other hand, mostly laid on the experimental aspects of the subject and the wealth of details given is apt to be a bit confusing to students of theoretical Physics. It is usually towards the end of the book that the classical equations of the Field Theory are deduced through which the final synthesis and fusion of the separate domains into one homogeneous whole can be achieved. This important task is, however, very often overlooked or is usually treated in a modest and neglected corner.

The author of the book under review prefers a different mode of exposition. Being one of a series of five works on theoretical Physics the book treats the subject of Electricity and Magnetism more or less in the same way as Mechanics of deformable bodies and of continuous material media are treated in the earlier volumes.

The ultimate aim of the theoretical physicist is to bring the divergent domains with their special laws under the sway of a minimum set of general principles from which all special laws would be deduced as particular cases. Such a survey of the whole field of physics from a single unitary standpoint is as yet unrealizable, but the author here has tried to bring about the rapprochement between the distinct subjects of Electrodynamics and Mechanics, by giving the principle of the conservation of energy and the principle of contiguous action a prominent position as in the other volumes.

A plausible deduction of the Laws of Maxwell is first attempted with the help of certain assumptions about the nature of electric and magnetic energies and with the idea of the flux of energy. Once the general laws of the Field Theory are established the author deduces the special laws of Electrostatics, Magnetism, Current Electricity and of quasi stationary electrodynamical phenomena, as special consequences of the same general equations which get more or less simplified owing to the special conditions which the electric and magnetic vectors satisfy in the different cases.

The principal consequences of the laws are then worked out for each of the separate branches of the subject, and the peculiarities of conception which the Field Theory involves are discussed lucidly and in a masterly manner. This survey of the whole field from a unitary standpoint proceeds systematically through domains of increasing complexity, and ends finally with the Electro-dynamics of moving bodies where already the weakness of the Maxwellian theory begins to show, and its failures and limitations are pointed out in the last chapter where references are also given to the greater generalizations achieved in this respect in recent times.

The perusal of the book will benefit immensely the reader who has got leanings towards the theoretical side of Physics; one should, however, remain conscious of the limitations of the method and of the one-sided character of such an account.

One of the advantages of the Field Theory according to the author is that the hypothesis of this theory are of more special nature

than the rival theories based on the principle of action-at-a-distance. It is pointed out that whereas there have been different theories of action-at-a-distance in Electrodynamics there has been only one, that of Maxwell, based on the principle of contiguous action. A fewer number of undetermined constants occur in the theory than in any other. This very special nature makes the Field Theory capable of making comparatively unambiguous predictions about future events; it thus achieves more as a theory, than any other rival theories in the same field.

The method of deduction of the Field Equations which the author pursues, however, does not at all make it clear or plausible that only one unique formulation is possible of the Field Theory. Even when one accepts the principle of conservation of energy, the existence of the vector of flux and the principle of contiguous action, a large margin of possible alternative solutions still remains. The unambiguous nature of the answer expected from the Field Theory is thus not self-evident. For example, even if one accepts that the flow-vector is completely determined at every point by the electro-magnetic state it is not at all clear why this particular vector should depend on 'E' and 'H' alone and not also upon their space and time differential coefficients. There is no *a priori* objection against such a hypothesis (on the Field Theory). Exactly the same criticism might be made against the method of deduction of the fundamental equations. Maxwell's equations are not the only solution which suggest themselves of the equation (52*a*) of p. 21. It is easy to conceive of other solutions equally simple which, however, differ from Maxwell's equations in having additional terms in the right hand side of 27 (*a*) and 27 (*b*). Even the additional assumptions that in the statical case the general equations should break up into two independent sets which 'E' and 'H' will separately satisfy, will not remove the ambiguity. In fact the uniqueness of the Maxwellian theory does not follow from the general principles from which the author starts.

It is well known that various attempts have been made from time to time to deduce the Field Equations from some general Mechanical Principle like the principle of least action, and every such attempt has failed. The justification of the Field Equations in the special Maxwellian form is as yet to be furnished only by the crucial experiments. The equations thus remain up to this time a convenient empirical hypothesis which furnishes the best fit to the observed facts.

The empirical nature of the Field Theory is apt to be a little overlooked in an exposition such as the author has given in the book under review. A more satisfactory and, to our mind, a more logical procedure would have been to take the Field equations as tested hypotheses and then to show as is usually done in some books that these equations are compatible with the mechanical principles of conservation of energy and momentum if certain quantities are taken as representing energies, momentum and flux vector in the electro-magnetic field.

One misses also in this book, a discussion of the Lorentz equations which preserve the advantages of the Field Theory so admirably and meets at the same time the demand for a hypothesis involving a discrete structure of electricity as revealed by experiments. Not only do the simple equations of Maxwell and Hertz prove inadequate for moving bodies as the author himself points at the end of the book, but its unsatisfactory nature is apparent as soon as a rational theory of the dielectric or conducting media is attempted. An additional chapter on this question would have been welcome.

However much we would have liked our author to have gone further in the exposition of his subject in certain directions, the book in its present form, presenting as it does an admirably simple and masterly exposition of the Field Theory of Maxwell and Hertz will prove certainly of immense benefit to all students of theoretical Physics. The translator of the book deserves our grateful thanks for thus making once more accessible to the students of Indian Universities a really good book bearing the impress of a master-mind.

S. N. BOSE.

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MODERN PHYSICS. *Lehrbuch der Theoretischen Physik*, Von. Joos. Akademische Verlaggesellschaft m. b. H., Leipzig 1932. Price 14 Marks.

The bold and rapid advances which, since the beginning of the present century, have revolutionised Physics, have also brought with them new problems for the teacher. The wealth of material which requires to be examined at least cursorily by every serious

student of Physics is now enormous and important additions are being made every day. To understand Modern Physics, however, a knowledge of much of classical physics is absolutely imperative and it is a difficult task to determine what should be included and what can be safely omitted. A number of attempts have been made in recent years to produce text-books which solve this problem, but in many of these the emphasis has not been properly divided between the old and the new and the two methods of approach have not been sufficiently well blended into a coherent mode of presentation. In both the balance with which the classical and modern portions have been treated and the unity of method by which the transition from the one to the other has been effected, Prof. Joos' "Lehrbuch der Theoretischen Physik" holds a position in the front rank. It is a perfectly modern book which yet conserves with reverence the heritage of the old masterpieces and knits the newer acquisitions with the old into an organic whole. In the classical portions the methods of presentation that have stood the test of time have been followed, innovation in this domain being regarded as the reverse of improvement. However, the arrangement of these has been so contrived as to provide a natural introduction to the modern developments which have been interwoven with the classical theory in an admirable manner. The power of condensation exhibited is marvellous and yet the physical principles are explained more thoroughly than would be expected from the range of topics included.

The volume is divided into seven books; the first is devoted to a brief and yet comprehensive presentation of those necessary branches of mathematics which the student at College has not already mastered. Of these, Vector Analysis occupies the larger part and is sufficiently fully developed. Introductory sketches of Tensor Analysis, Theory of Functions of a complex variable, and the Calculus of variations have been included. The theory of vibrations and waves is dealt with in a separate chapter. The second book develops the mechanics of a particle and of rigid bodies in the usual manner and chapters have been added on the essentials of the mechanics of deformable bodies and of fluids. The scope of these can be gathered from the fact that the symmetrical top, transverse vibrations of strings and membranes and Stokes' Law of the motion of a sphere through a viscous fluid and the theory of capillarity terminate the chapters on mechanics, elasticity and hydromechanics respectively. A final chapter deals with the special theory of relativity; the general theory is merely noticed in passing and its mathematical treatment has been omitted as being too difficult. The third book deals with electrostatics, magnetostatics, electromagnetics, and the electromagnetic theory of light. An account of high frequency alternating currents is also briefly given. The book closes with a chapter on geometrical optics. The fourth book treats of electrolytic conduction, conduction in gases, the elements of the theory of metallic conduction, atomistic theory of dielectric constants, refractive indices and magnetic permeability, and lastly the optics of moving media. The Debye-Huckel theory is described and Sommerfeld's theory of metallic conduction is also sketched without detailed mathematical treatment. The theory of the arc and glow discharge is given and Aston's Mass-spectrograph is described in connection with anode rays. The fifth and the sixth books are occupied with the theory of heat, the former from the phenomenological aspect and the latter from a statistical point of view. The theory of heat conduction, the equation of states, thermodynamics including the equilibrium of thermodynamic systems and applications of Nernst's heat theorem make up the fifth book. The sixth book is devoted to kinetic theory and classical statistics, Debye's theory of specific heats, theory of radiation and the Bose-Einstein and the Fermi statistics. The seventh and the last book touches upon the modern theories of atomic structure and quantum mechanics. The scattering of particles, Bohr's theory of the spectra of hydrogen and ionised helium, Moseley's law in X-ray spectra, the correspondence principle, the Zeeman effect, Pauli's principle and the structure of the periodic system and elements of the theory of band spectra, are all dealt with clearly and succinctly. The elements of wave-mechanics with applications to the Hydrogen spectrum, molecular spectra, dispersion and the Raman effect, and to Radioactive transformations are given. Some topics, not of sufficient importance to be included in the text, are given in the form of problems, hints for whose solution are given at the end of the book. One could have wished that

such topics as the theory of instruments of high resolving power, Saha's theory of thermal ionization, X-rays, radioactivity and nuclear structure might have been treated a little more in detail; but as the author says in the preface, the book is meant only to bring the earnest student to a vantage point from which the different peaks of physical knowledge can be surveyed and reached with greater ease by means of the guidance afforded. We can heartily say that this aim has been well achieved and an Honours student can desire no better book than that of Prof. Joos to give him an accurate and impartial orientation in the field of Physics. The printing and binding are of the same excellent quality as one is familiar with from the *Handbuch der experimental Physik* issued by the same publishers.

* * * B. V.

The Form and Properties of Crystals. By A. B. Dale. Pp x+186. (Cambridge University Press, 1932.) 6*s.* net.

This little book is intended by the author to serve as "an introduction to the study of minerals and the use of the petrological miscroscope" and help the students "to master the principles underlying the examination, measurement, and identification of minerals". Though hardly 200 pages in size, the book is a successful attempt in bringing together all the fundamental ideas bearing on the crystallographic, physical and optical study of minerals, in a form which certainly helps the student to appreciate the vital connection between these different aspects of mineralogy. The first four chapters deal with the nature, classification, internal structure and the general physical properties of crystals, while the remaining two chapters are devoted to the study of the optical properties of minerals. The fundamental principles of physical optics underlying the study of thin sections of minerals in polarised light are very clearly explained and the different methods of investigation of a mineral by means of the petrological microscope have been indicated. The numerous figures and diagrams found throughout the book go a long way in helping the student to understand clearly the subject-matter.

Though small in size, the book gives such a clear, though elementary, exposition of several important aspects of the study of crystals that there is no doubt it will be found useful not only by students of mineralogy and petrology but also by students of chemistry and others to whom crystals are becoming matters of increasing interest and importance.

L. RAMA RAO.

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Plane Trigonometry. By B. B. Bagi. Dharwar, 1931. Price Rs. 3.

It is very gratifying to note that, of late, a number of talented persons have been writing *Swadeshi* text-books on scientific subjects in a thoroughly modern and rigorous style. Mr. Bagi must be congratulated for his successful attempt in bringing forth a book embodying many interesting and original ideas. The book has been written with commendable care as regards mathematical rigour in the proofs and in the development of the subject. Special mention may be made of the chapter on inverse functions, whose accurate treatment by Mr. Bagi stands in contrast with that to be found in many English text-books.

The book will be a very valuable asset to all teachers of the subject, as well as to such of the students who show some ability in mathematics. Many, however, will not be able to agree with the author when he talks of "the maturer intellect and the higher level of mathematical knowledge of the students of Indian Colleges"—especially at the Intermediate Standard. Unless the book is made more interesting and less terrifying to the average student—be he of any nationality whatever—by inserting a large number of easy examples in most of the chapters, and by removing the harder ones to the end, the adaptability of the book as a *text-book* becomes difficult. In particular, the absence of chapters on solutions of right-angled triangles, and easy problems on heights and distances involving only right-angled triangles may be called a defect from the point of view of the beginner. These defects—which can be easily remedied in a second edition—do not, however, diminish the unquestionable value of the book to the teacher and to a large number of students.

C. N. S.

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Metamorphism. A study of the transformations of rock-masses. By Alfred Harker Pp. ix+360. (Methuen & Co., Ltd., London.)

The author of this treatise is well known in connection with two books which have had a far-reaching effect on geological thought. One, "The Tertiary Igneous Rocks of Skye", published in 1904, was probably one of the most fruitful investigations of its

kind ever undertaken. The other, "The Natural History of Igneous Rocks," although now a quarter of a century old, can still be read with great profit by students of petrology. The book now under consideration in no way falls below the standard of its predecessors, which is high praise indeed.

The study of metamorphism can be approached from two points of view, the descriptive, which regards metamorphic rocks simply as museum specimens to be studied for what they are; and the genetic, which pays more regard to metamorphism as a progressive process, and studies the changes through which rocks have passed during their geological history. The former, rather sterile point of view, has been the one adopted by the German school of petrologists, dominated by Grubenmann and his pupils. It has tended to divorce metamorphism from its place in geology, and, as the author aptly puts it, is a relic of the Wernerian school of geology. In the present treatise it is refreshing to find the subject treated in a more rational way, and the processes of metamorphism discussed in their relation to geological history.

Grubenmann, in his well-known treatise 'Die Kistallinen Schiefer', recognizes three grades of metamorphism, which he correlates with depths within the earth's crust. But this attitude ignores the fact that during metamorphism the earth's crust is in a disturbed state, and that the temperature gradient which prevails, and controls to a large extent the grade of metamorphism, has little relation to depth. Moreover, Grubenmann took no account of purely thermal metamorphism, which, being a special case, must be considered before a clear understanding can be gained of the more general problem. In the present treatise the author first examines the changes which all classes of rocks undergo when subjected to increasing temperature, and then discusses the more general, and more common, case in which temperature, hydrostatic pressure and shearing stress play their parts in varying degrees. It is further shown that although these three independent variables control the transformations which take place in regional metamorphism, they are so inter-related that it is possible to treat the problem much more simply, with temperature as the single variable to be considered. That this must be so to a large extent is clearly indicated in those areas of regional metamorphism in which it is possible to lay down successive zones of metamorphism, the lines separating the zones being both isothermal lines and isodynamic lines. The pioneer in this type of work was George Barrow, who, over forty years ago, mapped successive zones of metamorphism in the South-East Highlands of Scotland, each zone being characterized by a particular index mineral, those he chose being chlorite, biotite, almandite, garnet, staurolite, kyanite and sillimanite. This work is given a prominent place in the treatise under review, in that it illustrates well the principle that metamorphism is to be regarded as a progressive change, taking place in response to a continued rise of temperature, accompanied first by a rise and later by a diminution of shearing stress. But, in addition, the author treats of every possible combination of chemical composition, temperature, hydrostatic pressure and shearing stress that could possibly arise, and concludes with a chapter on "retrograde" metamorphism.

A criticism of the book which might well be offered by some is that it gives little reference to the work of petrologists outside the British Isles. But, as the author says in his preface, "Rather has it been my design to show that this country enjoys peculiar advantages as a field for research, and that British workers have not wholly neglected the opportunities so liberally offered", and anyone who has read the book will fully concur in this opinion.

The book is well got up, and is illustrated with several hundred drawings of rock sections done with the author's usual skill, which add greatly to the value of the work. Written as it is in a style which is above reproach, and containing as it does much of the philosophy of our science, this book, together with the same author's *The Natural History of Igneous Rocks*, might well be taken by students as a model upon which to fashion their own attempts at scientific presentation. As a treatise upon metamorphism it will long remain a standard work to be consulted by geologists; and it is perhaps characteristic of it to say that it will be more appreciated by field workers than by museum specialists. It is a book which worthily maintains the best traditions of British geology, which, ever since the days of Hutton and Lyell, have always been characterized by a certain sanity of outlook in approaching problems of this nature.

W. D. W.

Correspondence.

The Alimentary Glands of the Earthworm, *Eutyphœus*.

DR. G. S. THAPAR's note on the alimentary glands of the earthworm *Eutyphœus* published recently in *Current Science* [1] contains observations and ideas originally made and put forward by me and communicated already to the Indian Science Congress[2] and the U. P. Academy of Sciences.[3] In appropriating these results of mine, Dr. Thapar has made mistakes, which would not have occurred, had he confined himself to his own observations. For instance, in the last para of his note, he states: "The blood-supply of the glands is *from* the dorsal vessel and *from* the subneural vessel." As a matter of fact, a subneural vessel simply does not exist in *Eutyphœus*, much less supply blood to any structure. Further, even the dorsal vessel does not supply blood to the glands; it really collects blood from them. In the earlier part of the note, a statement is made that "the glands are separated from each other by intervening septa" (page 129). The fact is that instead of being separated as stated by Dr. Thapar, all the five pairs of glands form one continuous structure. This fact was noticed by Beddard[4] as early as 1889 and I have verified it. It cannot escape observation, if one were to examine the sections under the microscope even with a little care.

In my paper on this subject read before the Zoology Section of the Indian Science Congress at Allahabad (1930), I with Mr. M. B. Lal reported that the glands opened into the gut by several small or large openings all along their length, to which Dr. Thapar makes no reference in his note, in which he has recorded a similar observation. Further, I have recorded two experiments of mine on these glands to prove that they have a digestive (peptic) function. In a paper which I read at the Lucknow Meeting of the U. P. Academy of Sciences (Dec. 1931), I put forward the two ideas that the nature of the blood-supply of these glands suggested a hepatic portal system and that the function of the glands indicated that of a liver or hepato-pancreas. In support of these ideas, I adduced relevant evidence. It is difficult to believe that Dr. Thapar, working in the same Department and at the same place, was unaware of these conclusions of mine when he wrote (p. 130) that "the branches of both the vessels (dorsal and subneural) ramify in the substance of the glands and form a complete anastomosis, thereby indicating a kind of portal system. Further investigation may show that the glands are of the nature of a liver that pours a digestive secretion into the gut."

It is obvious that a portal system cannot be formed out of vessels, one of which, at any rate, is non-existent. Dr. Thapar has, of course, not seen the large *ventral-intestinal vessel* which exists in the worm and really supplies blood to the glands, and not the dorsal and subneural vessels as he has wrongly assumed. The ventral intestinal runs along the ventral wall of the gut for the last 107 to 127 segments of the worm. I applied the term "liver" to these glands after I had made sure of their correct blood-supply and ascertained their digestive function and again after I had obtained preparations showing glycogen granules, within the cells by staining them with Best's carmine, knowing full well that the more important function of the liver is to store absorbed food. It is necessary to draw Dr. Thapar's attention to the fact that a mere imaginary portal system such as he has ascribed to the glands with no further proof or evidence of their hepatic character cannot make a "liver" of them in the sense understood even by an elementary student of Zoology.

K. N. BAHL.

Dept. of Zoology,
Lucknow University,
December 15, 1932.

With reference to the above note of Dr. K. N. Bahl, I wish to mention the following points:—

1. Colonel J. Stephenson,[5] then Principal and Professor of Zoology at the Government College, Lahore, suggested the problem to me in a letter dated the 19th August 1918 (still in my possession) and as a result of my investigations during the years 1918—1922, I read a paper on the "Alimentary glands of earthworms of the genus *Eutyphœus*" at the Tenth Indian Science Congress in 1923, when Dr. Bahl was himself present, and in participating in the discussions supported my results. This he was able to do because he had access to all my preparations and dissections. In further discussions, one of the members raised the question of the functions of these glands, which were regarded as digestive, something of the nature of a liver.

2. Dr. K. N. Bahl has himself included the abstract of the paper in his quinquennial report of the department published by the University of Lucknow in 1928 (page 112) and has accepted the priority of my work.

3. The work was left unpublished, as soon after I proceeded to England for advanced studies, where the entire manuscripts with the accompanying diagrams were seen by some friends, who are now in the Universities in India. Having taken up an entirely different line of work in England, and also due to pressure of work since my return, I did not have time to publish the results of my work earlier.

4. The work on the Physiology of the glands, now claimed by Dr. Bahl as his own was actually carried out as late as 1929 by one of our former students, now colleague in the department.

Now to the mistakes pointed out, I would reaffirm my conclusions by saying that:—

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[1] *Curr. Sc.*, **1**, 128, 1932.
[2] *Proc. Ind. Sc. Congress*, Allahabad, 248, 1930.
[3] *U. P. Acad. Sc.*, Dec. 21, 1931.
[4] *Q.J.H.S.*, **29**, 114, 1889.

[5] Then you might investigate "The peculiar diverticula which you will probably find on the intestine about the middle of the body; are they always in the same segments, or is the position variable? What is their histology, and does it differ from the intestine in general?....Note also any particular features in the blood supply." Extract from a letter from Col. J. Stephenson, dated 19th August 1918.

1. The glands are not five pairs as mentioned by Dr. Bahl, but there are four to five *double*-paired bodies, as can be seen by unaided eyes even in ordinary dissection.

2. The point raised by him that the septa do not divide the glands is also misleading. The septa are clearly present, as can be seen from the accompanying figure, extending between the glands of each segment, at any rate in the two species investigated by me.

Fig. 1.

Longitudinal (vertical) section of E. waltoni passing through the glands, showing the extension of septa. s. septum.

3. Each pair of bilobed glands communicate with the intestine below by *two* pairs of apertures, one for each lobe, and not by "several small or large openings all along their length" as stated by Dr. Bahl. If he intends to see these structures clearly, he should employ *double embedding Celloidin* method when he would be able to cut complete series of sections along with the intestine and body wall and come to the same conclusions.

4. As regards the blood-supply, I am sorry for certain typographical errors [1] in my original note, but I find that Dr. Bahl has committed a serious mistake. On further investigation he will realize that it is not the *ventral intestinal vessel* as stated and traced by him from segments 107-27, but it is the *supra-neural (ventral) vessel* that supplies the glands. This supra-neural vessel, on reaching segment 84, sends a pair of branches

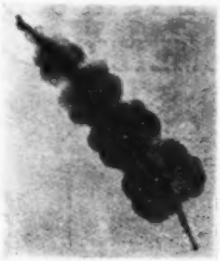

Fig. 2.

Glands seen from the ventral side, showing the distribution of the ventral blood-supply from the supra-neural vessel. Intestine is cut to show clearly the lateral loops (l).

that run laterally below the glands, one on either side and supplies blood by giving a branch to the glands in each segment (Fig. 2). This would still maintain the existence of a kind of portal system mentioned in my original note.

These facts will speak for themselves. It is needless to say that my note was a brief summary of the main facts dealt with in my longer paper, which was first sent to the Editor, *Current Science*, but from the nature of the work the entire manuscript could not be published. My critic probably thought that it was the last word I could write on the subject, but before he could discuss the morphological errors in my paper, he should have made conclusive observations himself and not have based his conclusions on meagre facts.

In fact I would not enter into controversy with Dr. Bahl, who claims to be "original author" of these glands, but I would certainly protest against his appropriation of the work of his colleagues and assistants. Dr. Bahl could have waited for the publication of my paper, which is now in press, when some further facts in the structure of these glands would also be known.

In conclusion, I am much indebted to the Editor for the courtesy shown in referring the counternote to me for a reply before its publication.

G. S. THAPAR.

Department of Zoology,
The University of Lucknow,
January 24, 1933.

[1] Errors in the original note:—read "supra-neural" for "sub-neural," and read in the references "Oxford, The Clarendon Press" for "Oxford University Press".